IRON ROOFS:

A SERIES OF EXAMPLES,

Illustrating various Combinations of Iron,

BOTH MALLEABLE AND CAST,

IN THE CONSTRUCTION OF ROOFS

FOR

WAREHOUSES, FACTORIES, RAILWAY STATIONS,

AND OTHER BUILDINGS,

From 20 *to* 150 *feet in Span;*

COMPRISING DETAILS OF THE ROOFS AT THE NEW PALACE AT WESTMINSTER, AND AT THE PENTONVILLE MODEL PRISON;
OF THE COMPOUNDED RAFTERS OF THE GREAT ROOF AT LIVERPOOL,
&c. &c. &c.

With Enlarged Sections
OF
THE PARTS OF SEVERAL ROOFS, ADMITTING OF READY ADAPTATION TO ALL INTERMEDIATE SPANS, AND TO ALL DESCRIPTIONS OF BUILDINGS.

BY

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IRON ROOFS.

If importance, in an economical point of view, be admitted as a recommendation to the study of the engineer and architect, the subject of iron roofs possesses strong claims upon their attention. Without contending that, in actual first cost, a roof may be constructed of iron by a less outlay than one of wood, we would beg to refer to those other constituents of economy, in the possession of which the former material ranks so far above the latter, that "first cost" becomes properly divested of much of its apparent impressiveness.

Durability and safety from destruction by fire are indispensable elements of economy, which the metallic material presents in a remarkable degree; and on this account iron has latterly been regarded with growing favour in the preparation of designs by the engineering and architectural professions. For the admission of air and light in the upper part of a building, a roof of iron enables us to command peculiar facilities, while in its applicability to span over large spaces, this material is incalculably superior to timber, however abundantly it may be employed.

PLATE I. contains elevations of two forms of iron roof, of which the first design is applicable for any spans from 20 feet upwards, with proportionate increase of scantlings, and the second is adapted for spans from 28 to 40 feet. In fig. 1, the rafter is of malleable T iron, with a cast-iron strut and wrought iron tie and truss rods. The strut being fixed at the middle of the length of the rafter, and the rods connected with the lower end of the strut secured at their other ends to the cast-iron shoe and king-head, constitute a trussing for the rafter, the intermediate horizontal rod being introduced to tie the ends of the corresponding struts together, and thus combine the two trussed rafters into one equilibrated principal. This roof, to which many similar ones have been erected, is shown as ventilated with a raised louvre, lighted with skylights. The lower

part of the roof is covered with slates, carried upon iron laths, and the water is delivered into a gutter fixed within the wall, and supported upon the rafter. The cast iron shoe is secured to the wall of the building with bolts, and the end of the tie-rod received in the shoe is formed with a fork to admit the rib of the rafter to pass between it and be secured in the shoe with one and the same bolt. The upper part of the strut is cast with three grooves to receive the rib of the rafter, which is secured within them by screwed bolts and nuts. The lower end of the strut is connected by a bolt, with the truss and tie rods. In another plate (IX.) two methods of effecting this connexion are illustrated, and will be described in a subsequent part of this description. The upper end of the rafter is bolted into the cast iron king-head, which is well designed also to secure the ends of the truss bars, and to support the skylights and ridge-covering.

Fig. 2 shows a front elevation of one of the skylights and louvres; and in conjunction with fig. 1, correctly exhibits all the details of this part of the construction. The lower ends of the skylights are supported upon the louvre-standards, which are of cast iron, and bolted with four bolts to the top table of the rafter. This standard is formed with a front flange and central back rib, so that its horizontal section is like the letter T. On each side of this central rib, four grooves are formed in the casting by projecting ribs, and these grooves being inclined, are fitted with the ends of continuous boards, which extend over the spaces between the principals, and thus admit the passage of air, but at the same time keep out all ordinary rains. The skylights are formed with bellied longitudinal bars, and fit upon skylight gutters, fixed over each principal, and bolted at the lower end to the bend of the louvre-standard. The ridge of the roof is covered with a continuous angular plate of cast iron; and over each principal, a separate casting or cap is fixed by a vertical bolt passing through a hollow boss upon the cap, and keyed by a socket formed on the top of the king-head, as shown in fig. 1. The principals are fixed at the distance of 5 feet 2 inches apart from centre to centre.

The principal, shown at fig. 3, adopted, as already stated, for spans from 28 to 40 feet, is constructed wholly of malleable iron, with the exception of the shoes, which are cast. Figs. 4 to 9 show the details of this roof; figs. 4, 5, 6, and 7 being drawn to half the real size, and figs. 8 and 9 to the real size. Fig. 4 exhibits a section of the rafter, &c., near the ridge; and fig. 5, a plan of the curved strip of iron by which a wrought wooden ridge is fixed to the rafters. Figs. 6 and 7 show a section and front elevation of the ridge of the rafters and the top of the king-rod, which is forked to receive the rafter and joint-plates, and

secured to them by means of a horizontal pin and key. Figs. 8 and 9 are transverse sections of the rafters and struts, which are all of rolled T iron, and of the following dimensions:—Rafter, $2\frac{1}{2}$ inches deep, and $2\frac{1}{2}$ inches wide over top table; rib, seven-sixteenths inch thick; top table, quarter inch thick; struts, 2 inches deep, and 2 inches wide over top table; rib, seven-sixteenths inch thick; top table, quarter inch thick; the tie-bar is quarter inch diameter; king-rod, three-quarter inch; and queen-rods, five-eighths inch diameter. The laths for the slates are of L iron, and filled in with strips of wood, by means of which the slates are nailed down.

It should be remarked, that the scantlings of this roof are somewhat less than can be ordinarily recommended. The following table presents the respective dimensions of section of rafters and struts for spans from 20 to 40 feet inclusive, of roofs constructed in the manner shown on fig. 3, plate I.:—

Span.	RAFTERS.				STRUTS.			
	Total Depth.	Thickness of rib.	Width of Top table.	Thickness of Top table.	Total Depth.	Thickness of rib.	Width of Top table.	Thickness of Top table.
Feet.	Inches.	Inch.	Inches.	Inch.	Inches.	Inch.	Inches.	Inch.
20	$2\frac{1}{2}$	$\frac{3}{8}$	2	$\frac{1}{4}$	2	$\frac{5}{16}$	$1\frac{1}{2}$	$\frac{1}{4}$
22	$2\frac{3}{4}$	$\frac{3}{8}$	$2\frac{1}{4}$	$\frac{1}{4}$	2	$\frac{3}{8}$	$1\frac{1}{2}$	$\frac{1}{4}$
24	3	$\frac{3}{8}$	$2\frac{1}{2}$	$\frac{1}{4}$	$2\frac{1}{4}$	$\frac{3}{8}$	$1\frac{3}{4}$	$\frac{1}{4}$
26	3	$\frac{3}{8}$	$2\frac{1}{2}$	$\frac{5}{16}$	$2\frac{1}{4}$	$\frac{3}{8}$	$1\frac{3}{4}$	$\frac{5}{16}$
28	$3\frac{1}{4}$	$\frac{7}{16}$	$2\frac{1}{2}$	$\frac{5}{16}$	$2\frac{1}{2}$	$\frac{3}{8}$	$1\frac{3}{4}$	$\frac{5}{16}$
30	$3\frac{1}{4}$	$\frac{7}{16}$	$2\frac{1}{2}$	$\frac{5}{16}$	$2\frac{1}{2}$	$\frac{3}{8}$	2	$\frac{5}{16}$
32	$3\frac{1}{4}$	$\frac{7}{16}$	$2\frac{3}{4}$	$\frac{5}{16}$	$2\frac{3}{4}$	$\frac{3}{8}$	2	$\frac{5}{16}$
34	$3\frac{1}{2}$	$\frac{7}{16}$	3	$\frac{5}{16}$	$2\frac{3}{4}$	$\frac{3}{8}$	$2\frac{1}{4}$	$\frac{5}{16}$
36	$3\frac{1}{2}$	$\frac{7}{16}$	3	$\frac{3}{8}$	$2\frac{3}{4}$	$\frac{3}{8}$	$2\frac{1}{2}$	$\frac{5}{16}$
38	$3\frac{3}{4}$	$\frac{1}{2}$	3	$\frac{3}{8}$	3	$\frac{7}{16}$	$2\frac{1}{2}$	$\frac{5}{16}$
40	4	$\frac{1}{2}$	$3\frac{1}{4}$	$\frac{3}{8}$	3	$\frac{7}{16}$	$2\frac{1}{2}$	$\frac{3}{8}$

PLATE II. exhibits the details of a wrought iron roof of 60 feet span, having raised louvres and cast iron skylights. Fig. 1 is an elevation of half a principal. The rafters and struts are of T iron, the tie and suspension-rods of round wrought iron, the shoes, king-heads, louvre-standards, skylights, ridge, ridge-caps, and skylight gutters, are of cast iron. The rafters are secured by screwed bolts and nuts to the cast iron shoes at their lower ends, and to the king-head at the upper end, the king-head having two flanges on each side, between which the rib of the rafter is received and bolted through them. At the three intermediate points, the rafter is connected with the struts and suspension-rods. The struts are sheared off at a bevel to fit the under side of the rib of the rafter. A coupling strip of plate iron is then rivetted on each side of the rib of the strut, and, projecting beyond it, these strips form a groove to receive the rib of the rafter. The suspension-rods are terminated at the top with forks, having eyes for bolts. These forks embrace the straps in the ends of the struts and the rafter between them, and a screwed bolt, passing through these several parts at each junction, and being secured with a tapped nut, securely fixes them in their permanent position. At the lower ends the struts have the rib sheared off to fit the bevel of the tie-rods, and the top table is turned in direction to lie upon the rod, and formed with a hole, through which, and also the tie-bar, the lower end of the suspension-rod is passed and secured beneath with a tapped nut. The end of the tie-rod within the shoe is forged square in transverse section, and a pair of wrought iron keys passed through its end, and also through holes in the sides of the shoe, give the means of securing these parts together, and also tightening the tie-rods to any required extent, to prevent sagging or irregularity in the roof. At the middle of the span, the tie-rods, each of which terminates in an eye, are united by bolts to two parallel horizontal discs of plate iron; the same bolts passing also through the feet of the principal struts formed in the manner already described. The king-rod passes through both of these discs or plates, and is nutted beneath them. These plates are also perforated with two other holes opposite to each other, and at right angles to those for the struts and tension-rods. These holes serve to connect longitudinal ties of iron, fixed thus between each contiguous pair of principals, and tying the principals together in the plane of the tension-rods, and thus aiding the ridge in resisting the diagonal twisting action of the wind under some circumstances.

Fig. 2 is a full-sized section of the rafters, which are $3\frac{3}{4}$ inches in depth; rib, half inch thick; top table, 3 inches by three-eighths inch. The principal struts, Fig. 3, are $3\frac{1}{4}$ inches deep; rib, half inch thick; top table, $2\frac{3}{4}$ inches by five-

sixteenths inch. Fig. 4 is a transverse section of the second and third pairs of struts, and is of the following dimensions: depth, 2¼ inches; rib, half inch thick; top table, 2½ inches by three-eighths inch. Figs. 5, 6, 7, 8, and 9 are full-sized sections of the frames and bars of the cast iron skylights. Fig. 5 is a section of the outer bars which are formed to hook over the edges of the gutter, fixed over each principal from ridge to head of louvre-standard, and between each two contiguous skylights. Fig. 6 is a section of the top bar of the frame at the middle, where the depth is increased. Fig. 7 shows a section of the same near the ends. Fig. 8 is a section of the bars which run parallel with the rafters, and have rebates for the glass. Fig. 9 shows the longitudinal bars of the frames, which are flat on the top, to allow the glass to be laid over them without interruption. Fig. 10 shows an enlarged view of the top of the king-head, with the holes for bolts to connect the rafters, and key-ways for the keys to fix small vertical bolts to hold the ridge caps down upon the king-head. Fig. 11 shows a transverse section of the cast iron ridge; and fig. 12 a side elevation and section of the same. Fig. 13 is a transverse view, and fig. 14 a side elevation, of one of the ridge-caps which are fixed over the king-heads. Fig. 15 is a transverse vertical section of the king-head, fig. 10. Figs. 16 and 17 represent the ends of a skylight gutter; and fig. 18 shows a cross section of the skylight gutter, and of the outer ribs of the skylights in their proper relative positions. Figs. 19 to 24 represent details of one of the louvre-standards and skylight gutters, with the means of connecting them with each other, and the former with the rafters. A horizontal tie-rod connects the louvre-standards with the king-head, and is keyed within bosses formed on the castings for that purpose. Fig. 25 is a plan of part of a skylight, and shows the bars of which the figures 5, 6, 7, and 8 are full-sized sections. Figs. 26 to 29 show, elevation, plan, front view, and transverse vertical section of one of the rafter-shoes, with the means of connecting the rafters and tie-rods within it. Figs. 30 and 31 show the circular discs of plate iron already described, for connecting the tie-rods, principal struts, king-rods, and longitudinal tie-rods together. Fig. 32 is an enlarged detail of one of the lower connexions of struts and suspension-rods. Fig. 33 is a plan of the end of a strut; fig. 34 a plan of one of the eyes forged in the tie-rods for the connexion, fig. 32; and fig. 35 is a plan of that end of the tie-rod which is to be secured in the rafter-shoe, and is forged square, and fitted with driving keys for that purpose.

PLATE III. exhibits a cast iron trussed rafter roof of about 26 feet span. In this roof, the truss and tie-rods only are of malleable iron, and the rafters,

struts, king-heads, louvre-standards, skylights, and skylight gutters of cast iron. Each rafter is in one casting, with hollow cylindrical bosses at the ends for receiving the ends of the rods, which are secured with keys.

Fig. 1 represents the elevation of half a principal; fig. 2, a horizontal plan of a skylight; and fig. 3, a longitudinal section through the same. Fig. 4 to 9 inclusive, all of which are drawn to the scale of 6 inches to a foot, or one-half the real size, show (in fig. 4) the king-head, with the mode of securing the ridge-cap and skylight gutters; (in fig. 5), the side view of the ridge-cap, section of skylights, and skylight gutter, and two bolts for the ridge-cap; (in figs. 6 and 7), back and side views of the louvre-standard, with ends and transverse sections of the louvre boards; and (in figs. 8 and 9), sections of a rafter, taken in the middle and near the ends. The dimensions of the sections of rafters, &c., are as follows:—Rafter, $4\frac{3}{4}$ inches deep throughout; rib, five-eighths inch thick; top flange, $2\frac{1}{2}$ inches by three-eighths inch throughout; bottom flange $3\frac{1}{2}$ inches by half-inch at middle, reduced to $1\frac{1}{2}$ inch by half-inch at ends. The lower end of the rafter is shown supported upon the side of a continuous cast iron gutter, bearing a similar roof on the other side, and resting upon cast iron columns. At the upper extremities, the rafters are fitted to meet in a vertical joint, and connected with screwed bolts and nuts, the fixing being helped by the manner of attaching the king-head, which has two bolts through each of the rafters. The skylight gutters are secured to the king-heads, and also to the top of the louvre-standards by means of screwed bolts and nuts, and the feet of the louvre-standards are similarly attached to the cast iron rafter. The principals are fixed 6 feet apart from centre to centre.

PLATE IV. shows in detail a construction of cast iron rafter roofs, adapted for cases in which piers of brickwork or other intermediate supports can be had for the rafters. The design here exhibited is that adopted in the roofing of the New Pentonville or Model Prison, and par example, in many other Government prisons. The span of this roof is forty-five feet; and each rafter consists of three castings, being supported upon two piers of brickwork. No trussing is needed, and the only rods introduced are a short king-rod, and a tension rod connecting it with the upper shoes. Fig. 1 is an elevation of half a principal. Figs. 2 and 3 are transverse sections of a rafter taken at the ends and at the middle where the depth is increased. Fig. 4 shows a plan of the middle shoe (B, fig. 1), and a horizontal sectional view of the lower and middle rafters resting within the sockets formed in the shoe, the ends of the rafters having projecting vertical ribs

to secure them in the shoe. Fig. 5 is a similar plan of the lower shoe (A, fig. 1), and the foot of the lower rafter resting within the socket in the shoe. Fig. 6 is a side elevation of the upper shoe, and shows the mode of inserting the tie-rod, and securing it with keys passing through the shoe. These shoes are each 9 inches square in the bottom plate, and have four holes for securing to the masonry or brickwork by bolts or otherwise. Figs. 7 and 8 are side elevation and horizontal section of the coupling of the upper rafters and connexion of the king-rod with them, by means of a screwed bolt which passes through the rafters, and an eye formed in the head of the king-rod. The upper rafters have each a vertical flange cast upon it; so that when the rafters are coupled together, these two flanges form a recess for the ridge, which is of wood, and secured in its place by bolts passing through holes in the flanges. Figs. 9, 10, and 11 show sections and elevation of end of the cast iron laths employed, having been substituted for those of the T section shown in the elevation of principal, fig. 1. Fig. 9 is a transverse section at the ends; and fig. 10, a similar section in the middle, where the depth is increased. Each end of each of these laths is formed as a dovetail, and is received in a cavity of similar form in the upper surface of the rafters. Fig. 12 shows an elevation of one of these cavities on a rafter; and fig 13 is a plan of the same portion, having a lath fitted in one cavity, and the corresponding one on the other side of the rafter vacant. The principals are fixed at the distance of 8 feet 6 inches from centre to centre, being the width (7 feet) of one cell in the gallery of the prison, and the thickness of the intermediate wall (1 foot 6 inches). The roof is covered with slates, the nails of which are turned up under the laths. Fig. 14 shows a side elevation of the end portions of the lower and middle rafters meeting in the shoe B (fig. 1), with the vertical ribs for fixing in the shoe, and one of the cavities for a lath. Figs. 15 and 16 are elevation and plan of the middle portion of the tie-rod, and the lower end of the king-rod secured beneath it by a tapped nut. Of the remaining figures (all drawn to the scale of one-fourth the real size, or 3 inches to 1 foot) fig. 17 is an elevation of the heads of the upper rafters; fig 18, the king-rod; and fig. 19, a transverse section of one of the cast iron gutters. The several lengths of gutter are fixed together by four screwed bolts and nuts at each joint through internal flanges, a shallow rib being continued across the bottom of the gutter to assist in making a water-tight joint. This rib has also the effect of retaining usually a small quantity of rain-water in the gutters, and thus preventing them becoming utterly dry, which is known to be practically injurious to the soundness of this part of the work. Fig. 20 exhibits a plan of portions of gutters, showing

the semicircular openings in the bottom of the gutter for discharging into the rain-water head, within which the ends of the gutters have these open joints; and showing also one of the bolted joints, with the projecting flange, by which the ends of the gutters have an increased bearing upon the walls. Fig. 21 is a front elevation of one of the rain-water heads, which are moulded to correspond with the elevation of the gutters, and have a reduced pipe below for fitting into sockets cast on the down pipes.

PLATES V. and VI. represent the roofs of cast and wrought iron erected at the new Palace at Westminster, which are among the largest specimens of iron roofs constructed, and exhibit the somewhat novel introduction of cast iron as the material of the covering of the roof. These are, therefore, to be regarded as *complete iron roofs*, consisting entirely of metal, and presenting a judicious combination of malleable and cast iron, which manifests both skill and boldness on the part of Mr. Barry and his professional assistants. The span of these roofs is about 45 feet, and their height, from the bottom of the tie-bar to the ridge of the top flat, 21 feet. The rafters, both principal and common, and the horizontal and raking beams beneath the top flat, are of rolled T iron; the suspension and tie-bars of malleable bar iron; and the struts, shoes, and connecting sockets, as also the purlins and longitudinal horizontal bearers, of cast iron. The sectional dimensions of the several parts are as follow:—Principal rafters, 6 inches deep; rib, 1 inch thick; top table, 3 inches wide. Common rafters, 3 inches deep; rib, half inch thick; top table, 2 inches wide. Main or lower tie-bar, 5 inches by 1 inch. Upper tie-bar, 4 inches by 1 inch. Suspension-bars, (from J to M, fig. 1, Plate V.,) 4 inches by 1 inch. Ditto, (from C to N,) 3 inches by 1 inch, and double. Ditto, (from B to F,) 2½ inches by three quarters inch double; and ditto, (from H to O,) 4 inches by 1 inch. The horizontal beam or principal rafter beneath the top flat, (from C, fig. 1, Plate V. to the corresponding angle on the other side of the roof,) is of the same iron as the other principal rafters—viz., 6 inches deep by 1 inch rib; and 3 inches wide over the top table. The raking beams, or common rafters, which carry the top flat, are 2½ inches deep by half inch rib; and 2 inches wide over the top table. The principals are fixed about 7 feet 6¾ inches apart from centre to centre. The longitudinal wall plate at L, fig. 1, Plate V., and the purlins at K, J, D, C, B, and A, are, as already stated, of cast iron. Two sets of common rafters are used between each contiguous pair of principals, and are supported upon the purlins. The distance between the centres of the common rafters is thus 7 feet 6¾ inches ÷ 3 = 2 feet

6¼ inches. The dimensions of the purlins, &c. are as follow:—Those above A and B, fig. 1, Plate V. are 4 inches deep, 2 inches wide over the top, and half inch metal. Those over the queen-heads at C, 4¾ inches deep, and half inch metal. The middle purlins, at J, are 7 inches deep; rib, three-quarters inch thick; bottom flange, 2¾ inches by three-quarters inch. The intermediate purlins at D and R are 5 inches deep and half-inch metal. The lower floor and ceiling beams (of cast iron) at L, M, N, O, are 7 inches deep; rib, three-quarters inch thick; top flange, 4 inches by three-quarters inch; and bottom flange, 1½ inches by three-quarters inch. The middle floor beams (of cast iron) at E, F, H, are 6 inches deep; rib, three-quarters inch thick; top flange, 1⅝ inch by three-quarters inch; bottom flange, 3¼ inches by three-quarters inch. The several cast iron struts are of the cross section, and of two sizes. Those from J to N, from H to N, and from A to E, are 6 inches by 5 inches, and 1 inch thick throughout. Those from D to E, and from K to M, are 4 inches by 3 inches, by 1 inch thick throughout. The manner in which the several members are connected together will be apparent from the details shown in Plates V. and VI., with the following reference to the several figures:—On Plate V., fig. 1, is an elevation of a complete principal, as already referred to; the masonry of the wall and the gutter, shown on one side, being necessarily omitted on the other for want of space. Fig. 2 is an enlarged elevation of the queen-head at C. Fig. 1 and fig. 3, a transverse section through the rafters at A A, fig. 2, showing the side of the queen-head and purlin. Figs. 4 and 5 are enlarged elevations of the connexions at A and B, showing the sockets in which the rafters are secured, and sections of the purlins. Fig. 6 represents the middle portion, at G, of the strut A E, fig. 1, the ribs of which are cast with mortices, through which the wrought suspension double bars B F, fig. 1, are passed and secured with a bolt through the eye of the boss shown on the figure. Fig. 7 is an enlarged elevation of the connexion at J, fig. 1, showing the several bolts, &c. for securing the tie and suspension-bars and strut. Figs. 8 and 9 are transverse and front views of the connexion at E; and fig. 10 is a plan of the same. Fig. 11 is an enlarged elevation of the connexion at F; and fig. 12 is a similar view of that at H. Fig. 13 is an enlarged section of the purlin over the queen-head at C, fig. 1. Fig. 14, an enlarged section of the purlins at A and B, fig. 1. Fig. 15, an enlarged section of the middle purlin at J; and fig. 16, of the middle floor beams at E, F, H. Fig. 17 is an enlarged section of the purlins at D and K. Fig. 1 is drawn to the scale of half-inch to 1 foot. Figs. 2 to 12 are to the scale of half-inch to 1 foot; and figs. 13 to 17 are drawn to the scale of 3 inches to 1 foot, or one-fourth the real size.

The roof, as shown in fig. 1, Plate V., is provided with cast iron dormers, by which light is admitted to the rooms or compartments in the roof. This figure shows also the sections of the cast iron covering plates, and the half-round ridge cover or capping by which the meeting of the plates is surmounted.

PLATE VI. contains the remaining details of these roofs, and the figures are numbered consecutively after those on Plate V. Fig. 18 is a plan of a portion of the roof, showing the cast iron dormer windows by which the rooms and repositories in the roof are lighted. It also shows a plan of one of the open gratings with which the capacious cast iron gutters are covered. Fig. 19 represents a plan of a similar portion of the framing of the roof, P P being two of the principals, and C R, C R indicating the position of the two intermediate common rafters, supported upon the cast iron purlins before described.

Figs. 20 to 25 show the details of the galvanized cast iron plates with which the roofs are covered, and the manner in which the joints of the plates over the rafters are covered with separate cast iron rolls. On fig. 22, the dotted lines *a a* and *b b* show the position of two contiguous rafters. In this figure the depth of the plate is necessarily shortened; but the exact dimensions in all directions can be readily ascertained from the elevation, fig. 1, Plate V., with the partial plan, fig. 18, Plate VI. The remaining figures (26 to 36 inclusive) show details of the lower connexions of the parts of the roof in the line of the main tie-bar and ceiling beams. Fig. 26 exhibits the foot of a common rafter, supported in suitable ribs on the wall-plate. Figs. 27 and 28 show the connexion of minor struts with the rafters, the intermediate purlins, sections of principal and common rafters, wall-plate and ceiling beam, and side elevation of the shoes. Fig. 29 is a side elevation of the shoe, showing the tie-bar in section with the wall-plates, ceiling beams, &c. Fig. 30 is a plan of the shoe, showing the ceiling beam and wall-plates in their places, and the bolts by which the latter are secured to the flanges of the shoe. Fig. 31 is a side elevation, and fig. 32 a sectional plan, of one of the lower connexions with the tie-bar, ceiling beams, suspension-bar, and cast iron struts in their several relative positions. Fig. 33 is an elevation of the middle lower connexion, and fig. 34 a transverse section, of one of the cast iron struts, of which the dimensions are already stated at length. Fig. 35 is a transverse elevation of the connexion shown at fig. 33; and fig. 36 shows the remaining lower connexion of tie-bar, suspension-bar, and ceiling beam.

PLATE VII. contains particulars of two designs for large roofs—one of

malleable iron, 154 feet in span; the other of cast iron, and 55 feet in span. A roof of the former kind has been recently erected over the railway station at Lime Street, Liverpool, and one of the latter kind over the Museum of Economic Geology in London. Fig. 1 shows the elevation of a principal, 154 feet in span, whereof the curved rafter, A A, fig. 1, and fig. 2, is compounded of a rolled bar of double T section, (R) with a top plate, (S S) rivetted to it, and side plates or flitches (Q Q) bolted through the rib of the central bar. The sectional dimensions of this compounded rafter are as follows:—Central bar, 9 inches deep; rib, five-eighths inch thick; top table 4 inches by seven-sixteenths inch; bottom table, 3 inches by seven-eighths inch; top plate, 10 inches wide, and seven-sixteenths inch thick; side plates, seven-eighths inch thick each, and 7 inches wide or deep; total thickness of rafter, $2\frac{3}{8}$ inches; the struts, B B, fig. 1, and fig. 3, are rolled bars of the double T section; the ties F and G are rods; the tension bars C C are double flat bars, fig. 5, and the tension rods D E are in sets of three, as shown at fig. 4. Fig. 6 shows a top plan of part of a rafter, with the rivets connecting the top plate S S with the central bar R, fig. 2. These rivets are 12 inches apart, arranged alternately, as shown in fig. 6. Figs. 7 and 8 exhibit the manner of connecting the rafter A and struts B with the tension bars D and rods E, and the ties F. Fig. 11 is a diagram, showing the manner in which the principals are connected, by means of frames of T and L iron, on the plane of the rafters. The transverse bars, fixed between the principals, are compounded of a central bar of T iron, with two side bars of L iron, as shown in the section fig. 10, taken at O O, fig. 11. These L bars diverge towards the ends, and are curved in a semicircular form, meeting the rafters at intermediate points. Fig. 9 shows a section at N N, fig. 11.

Fig. 12 represents a principal of the cast iron roof erected over the Museum of Economic Geology, being 55 feet in span between the centres of the standards, with an additional span of 5 feet 11 inches within the walls on each side. The principal consists of five castings, meeting in radial joints with flanges, and fixed with screwed bolts and nuts. The central portion of the roof is covered with sashes of wrought iron moulded bars T T. The unglazed portion of the roof is covered with three-quarters inch slate slabs. Fig. 13 is a section of the lower casting at Z, fig. 12, which is 13 inches in total depth, 6 inches wide over the flange, and $1\frac{1}{2}$ inch metal. Fig. 16 is a section of the same casting at Y, fig. 12, 1 foot 6 inches in total depth, 6 inches wide at the middle, and $1\frac{1}{2}$ inch metal. Fig. 17 is a section of the same casting at X, fig. 12. Fig. 14 is a section of the intermediate casting at W, which is 1 foot 6 inches in total

depth, 6 inches wide at the middle, and three-quarter inch metal. Fig. 15 is a section of the central casting at V, fig. 12, and is 2 feet in total depth, 6 inches wide over the top and bottom flanges, and three-quarters inch metal.

PLATE VIII. shows the particulars of three examples of iron roofs, viz. a wrought iron roof, 61 feet in span, a wrought iron roof 50 feet in span, and a double bar rafter roof 48 feet in span.

The first of these (figs. 1, 6, 7) consists of T iron rafters and struts, in the latter of which, two bars are used and fixed together through their flanges, by means of rivets three-eighths inch in diameter, placed 6 inches apart alternately on each side. Fig. 1 is a diagram of the elevation of this roof. Fig. 2, a full sized section of the T iron rafter. Fig. 3, a full sized section of a compound strut formed in the manner just described. Figs. 4, 5, and 6 exhibit the manner of connecting the head of the strut with the rib of the rafter, by cutting away the flange of the T bars of the strut, and fitting a coupling plate on each side. Fig. 7 shows the foot of a strut, and its connexion with the tie-rod and suspension-rod. The dimensions of the rafter are as follows:—Depth, 4 inches; rib, three-quarters inch thick; top table 4 inches by half-inch; the T iron of which the struts are composed is $2\frac{1}{2}$ inches in depth (making the total sectional depth of the strut equal to 5 inches); rib, three-eighths inch thick; top tables, $2\frac{1}{2}$ inches by three-eighths inch; the tie-rods are $1\frac{3}{8}$ inch in diameter; king-rods of the same size; queen-rods, $1\frac{1}{8}$ inch in diameter; and the second pair are seven-eighths inch in diameter.

The second roof shown in this plate, figs. 8 to 13, has T iron rafters and struts with rods for ties and suspension. Fig. 8 is a diagram of the elevation of a principal, showing the lines of the several members of the roof. Fig. 9 is a full sized section of the rafters, $3\frac{1}{2}$ inches deep; rib, half-inch thick; top flange, 3 inches, by three-eighths inch. Fig. 10 is a full sized section of the principal struts, $2\frac{1}{2}$ inches deep; rib, three-eighths inch thick; top table, $2\frac{1}{2}$ inches, by three-eighths inch. Fig. 11 is a full sized section of the minor struts, 2 inches in depth, by three-eighths inch thickness; of rib and top table also, 2 inches, by three-eighths inch. Fig. 12 shows the cast iron king-head, in which the heads of the rafters are secured; and fig. 13 is an elevation of the junction of tie-rod, struts, and king-rod.

The third roof shown on this plate, figs. 14 to 24, is composed of double bar iron rafters, cast iron struts, and bar iron ties. Fig. 14 is a diagram of the elevation of one of the principals, showing the lines of the several members of the

principal. Fig. 15 shows a full sized section of the rafter bars, which are each 3½ inches by half-inch. Fig. 16 is a full sized transverse section of a strut at the middle; and fig. 17, a similar section taken near the end. Fig. 18 shows the manner of fixing the head of the strut between the bars of the rafter by means of a bolt; and figs. 19, 20, and 21 represent the lower ends of the struts as adapted for meeting at one bolt, and being connected by it with the tie-bars. The bar, which is keyed into the rafter-shoe, is shown as continuous to the king-head, being welded and formed, as shown at fig. 20. The horizontal tie-bar, 2 inches by half-inch, is forked at the end, fig. 21, and thus embraces the bar, fig. 20. The struts pass outside of these, and are fixed together with one and the same bolt. Figs. 22, 23, and 24, show a side elevation, front view and plan of a rafter-shoe, which is similar on both sides, being adapted for another principal.

PLATE IX. represents a double bar iron rafter roof, with cast-iron struts, of 38 feet 9 inches span. Fig. 1 is an elevation of a principal; figs. 2 and 3 an elevation and plan of part of a rafter, showing the cast iron distance pieces or blocks, fig. 4, rivetted between them; figs. 5 and 6 represent the front and side views, enlarged, of the head of the cast iron struts, bolted through the rafters, fig. 6 being taken on the line A A fig. 5; figs. 7, 8, and 9, show the cast iron king-head, ridge-plate, and cap, with the manner of securing the heads of the rafters and the ends of the truss rods; fig. 9 is a transverse section through the centre of fig. 7, and fig. 8 is a plan of the rafters, ridge, and cap; figs. 10, 11, and 12, represent a method of connecting the foot of the strut with the three truss and tie-bars, fig. 10, having the moulded circular washer removed, to show the enlarged ends of the three rods resting in sunk places in the casting of the struts. In fig. 11 the washer is replaced, and in fig. 12 a section is presented through the strut and the washer. Figs. 13 to 16 represent the rafter-shoe adapted for this roof, fig. 13 being a side elevation, fig. 14 a plan, fig. 15 an elevation of the back of the shoe, and fig. 16 a transverse vertical section on the line B B, fig. 13. Figs. 17 to 23 show the details of another method of effecting the junction of the strut with the tie and truss rods, the several parts of which will be evident by inspection. Figs. 24 and 25 show another method of compounding the rafters—viz., by introducing a rib of wood between the iron bars of the rafter and bolting them through. This method has been much adopted on account of the facility thus afforded for nailing the boarding, or securing the slate covering of the roof.

PLATE X. exhibits the details of a wrought iron double L raftered roof of 60 feet span. Fig. 1 is an elevation of half a principal. Fig. 2 is a transverse section of one of the rafters which are compounded of two bars of L iron, with cast iron distance pieces or blocks rivetted between them. The rafters are each 4 inches deep, and $1\frac{1}{2}$ inch over the flanges; the metal is three-eights inch thick in the rib; and the flange is reduced to five-sixteenths inch at the edge. The distance between the two bars is $1\frac{3}{8}$ inch. Fig. 3 shows a full-sized section of the hip rafters, and those for principals next to the hip, strengthened with two additional bars of iron 4 inches × three-eighths inch. Figs. 4 and 5 represent the front view of one of the blocks, and the under side plan of part of two of the ordinary rafters with the block rivetted in its place. The rivets are half-inch in diameter. The tie-bars are single, and of the following dimensions:—Between the shoe and the first connexion of strut, $3\frac{1}{2}$ inches × nine-sixteenths inch; the remainder of bars, $3\frac{1}{2}$ inches × seven-sixteenths inch. The tie-bars for the hip principals are 4 inches × three-quarters inch throughout. The king-bars are single, and $2\frac{1}{2}$ inches × half-inch. Those for the hips are 3 inches × nine-sixteenths inch. The other suspending-bars are, in the common principals, 2 inches × three-eighths inch, single; those for the hip principals, 2 inches × half-inch. The struts are of double bars, bolted together, with washers between them. The principal pair are, in the common principal, of bars, $2\frac{1}{2}$ inches × half-inch; those for the hips, 3 inches × nine-sixteenths inch. The second pair are, for the common principals, of bars, $2\frac{1}{2}$ inches × three-eighths inch; for the hips, $2\frac{1}{2}$ inches × half-inch. The third pair are, for the common principals, of bars, 2 inches × three-eighths inch; for the hips, $2\frac{1}{2}$ inches × half-inch. The louvres are 4 feet in height, and consist of cast iron standards bolted to the rafters, and sheet iron plates one-eighth inch thick, curved to the form shown in fig. 1, and enlarged in fig. 14. The louvre-rafters are shown of the full size in fig. 12. They are composed like the rafters of two bars of L iron, but of less scantling—viz., 3 inches in depth, three-eighths inch thickness of rib; $1\frac{1}{4}$ inch wide over the flange, and fixed at the distance of $1\frac{1}{8}$ inch apart. The purlins throughout are of T iron of the section shown full size in fig. 13, $2\frac{1}{2}$ inches deep; rib, three-eighths inch thick; $2\frac{1}{2}$ inches wide over the table, and quarter-inch thick. Figs. 10 and 11 show a method of securing them by bolts in cast iron cheeks, which, being rivetted between the rafters, serve as blocks or distance-pieces at the same time. Fig. 10 is a front view of one of these castings; and fig. 11 a side view, showing the junction of two of the purlins and the bolts securing them. Fig. 14 is a view of part of the louvre-standard, showing one of the curved

weather-plates, bolted to a snug cast upon the standard. Fig. 15 represents the side view of the top of a louvre-standard, with the position of the louvre-rafters indicated by dotted lines. Figs. 6, 7, 8, and 9 show the manner in which the junctions of the tie-bars, suspending-bars, and struts may be effected. Fig. 6 is a front view, enlarged, of one of these junctions, the strut S T having an outside plate rivetted on each side, which form a fork to embrace the tie-bar, T B, with its coupling-plate fixed on each side of it. The ends of the tie-bars are removed from each other so as to admit the single suspending-bar S B between them, which occupies the cavity thus formed between the coupling-plates of the tie-bars, and is secured with the same bolt which fixes the ends of the strut coupling-plates. Fig. 7 shows a sectional plan of the suspending-bar S B in its place between the tie-bars and their coupling-plates, the strut being removed. Fig. 8 shows a plan of the strut with its coupling-plates, and the outside moulded cast iron washers, which are fixed over the connecting bolt, shown separately at fig. 9.

The roof is covered with galvanized corrugated iron, rivetted through the top table of the T iron purlins.

It is submitted that the Illustrations here presented and described form a collection of useful studies, for all who desire to be acquainted with the varied applications of iron in the construction of roofs of all dimensions; while, to the practical engineer and architect, they will serve as records of actual works upon which to found his own adaptations, and confidently establish his own improvements.

Savill and Edwards, Printers, 4, Chandos-street, Covent-garden.

A

RUDIMENTARY TREATISE

ON

MASONRY AND STONECUTTING.

PLATES.—PARTS I. AND II.

PART I.—PLATES 1 TO 8,

CONTAINING FIFTY-ONE DIAGRAMS ILLUSTRATING THE TEXT.

PART II.—PLATES 9 TO 16,

SPECIMENS OF GOTHIC MASONRY SELECTED FROM THE FOLLOWING CHURCHES,

VIZ.

ST. JOHN THE BAPTIST, BISHOPSTONE, WILTSHIRE;
ALL SAINTS, MAIDSTONE, KENT;
ST. MARGARET, STOKE GOLDING, LEICESTERSHIRE;

AND COMPRISING EXAMPLES OF

PIERS, ARCHES, BUTTRESSES, DOORWAYS, WINDOWS, PARAPETS, GABLE CROSSES, SEDILIA, ETC.;

MAKING IN ALL SIXTEEN PLATES, LITHOGRAPHED BY J. B. JOBBINS,

UNDER THE DIRECTION OF

EDWARD DOBSON, ASSOC. I.C.E. AND M.R.I.B.A.;

AUTHOR OF "THE RAILWAYS OF BELGIUM," "RUDIMENTS OF THE ART OF BUILDING," ETC.

LONDON:
JOHN WEALE, 59, HIGH HOLBORN.

1849.

NOTICE.

It was originally intended to publish the "Treatise on Masonry and Stone Cutting" in a single volume, but as this was found to be impracticable on account of the extent of illustration required, it has been determined to publish the plates and text separately, and to extend the original design of the work by adding to it a series of specimens of Gothic Masonry, comprising examples of Piers, Arches, Buttresses, Parapets, Gable Crosses, Doorways, Windows, Sedilia, &c., selected from the churches of St. John the Baptist, Bishopstone, Wiltshire; the collegiate church of All Saints, Maidstone, Kent; and St. Margaret, Stoke Golding, Leicestershire; of which elaborate illustrations engraved by J. Le Keux and W. A. Beevor were published a few years back in Weale's "Quarterly Papers on Architecture." The subjects here given have been selected from these illustrations, and carefully transferred to stone from the original plates, and it is confidently hoped may prove of service to working masons engaged in church reparation or restoration, who have not the means or the opportunity of studying expensive works on Church Architecture.

December, 1849.

PART I.

LIST OF ILLUSTRATIONS.

REFERENCES TO TEXT.

No. of Plate.	Fig.	Art.	Description.
1	2	7	Method of obtaining the profile of a groin by means of ordinates.
	3	8	Roman groined vault, with waving groins.
	18	79	Diagram showing the best way of setting off a right angle.
	19	82	Solution of right-angled triangles.
	20	83	Diagrams illustrating problems on circular curves.
	21	84	
	22	86	
	23	86	
	24	87	
	25	88	
	26	91	Mode of drawing an ellipse.
	27	93	Another method.
	28	94	A third method.
	29	99	Diagram illustrating the manner of obtaining the lengths of lines inclined to the horizon from their plan and elevation.
2	11	39	Diagram illustrating the common method of building an oblique arch.
	12	41	Diagram illustrating Mr. Hart's system.
3	13	42	Diagram illustrating Mr. Adie's system.
4	37	102	Development of a sphere.
	38	109	Diagram illustrating the projections of the cone.
5	43	120	Diagram illustrating the projection of spirals on a cylinder.
6	44	126	Method of drawing an oblique arch with a curved face.
	45	128	Intersection of semi-cylindrical vaults of equal span.
	46	131	Welsh groins.
	47	133	Intersection of a hemispherical dome with four semi-cylindrical vaults.
7	71	163	Diagrams illustrating the construction of battering wing-walls, on a curved plan, with conical beds.
	72	164	
	73	165	
	74	169	Mode of working the voussoirs of a dome with the least waste of stone.
	75	170	Different methods of working the soffit of an arch.
	76	170	

No. of Plate.	Fig.	Art.	Description.
			Oblique Arches.
7	77	171	Diagram explaining the construction of an oblique arch.
8	78	174	Diagram showing the adjustment of the angle of intrados to be unnecessary in a brick arch with stone quoins.
	79	176	Method of cutting the backs of the springers to bond with the masonry of the abutments.
	80	180	Diagram illustrating the calculation of the principal dimensions of a skew arch.
	81	189	Method of finding the templets for working the skewbacks.
	82		
	83	191	Twisting rules.
	84	192	Diagrams relative to the method of finding the templet for the curve of the soffit.
	85		
	86		
	87	198	Templet for marking the heading joints on the beds.
	88	196	Diagrams illustrating the mode of applying the templets in working the voussoirs.
	89		
	90	199	Instrument for measuring the angles of the coursing and face joints.
			Groined Vaulting.
			Roman Vaulting.
	91	203	Diagrams illustrating the manner of working the groin-stones.
	92	204	
			Gothic Vaulting.
	93	209	Plan of a quarter of one compartment of a ribbed vault, with the elevations of the ribs.
	94	210	Different methods of adjusting the curvature of the diagonal ribs.
	95		
	96		
	97		

END OF PART I.

PART II.

SPECIMENS OF GOTHIC MASONRY.

REFERENCES TO PLATES.

No. of Plate.	Fig.	Description.
9	1	Elevation of one of the nave arches, St. Margaret's, Stoke Golding, Leicestershire, showing also the font, which is in its original situation.
	2	Plan of the jamb mouldings and of one of the piers, the filleted moulds and deep hollows of which have a rich and bold effect. A plan of the base is also shown.
	3	Plan of the arch mouldings over the same jamb and pier, on the spring line, the label moulding being also given and a plan of the abacus of the capital.
	4	Section of the bases of the piers.
	5	Section of the capitals of the same.
		N. B.—These arches appear to have been built in the latter part of the reign of Edward III.
	6	Section of the jamb of the great chancel arch, All Saints, Maidstone.
	7	Arch mouldings of same.
	8	Section of base of pier shafts of ditto.
	9	Section of cap to pier shafts of ditto.
	10	Elevation of doorway into rood turret, All Saints, Maidstone, with detail of jamb mouldings.
	11	Elevation of vestry doorway, All Saints, Maidstone.
	12	Details of jamb mouldings to ditto.
		N. B.—The church of All Saints, Maidstone, was built at the end of the 14th century.
10	1	Elevation of part of the south front of the chancel of the church of St. John the Baptist, Bishopstone, Wiltshire, showing the design of the buttresses, parapet and windows, and the priest's entrance, remarkable for its very elegant porch, which is unique of its kind.
	2	Elevation of priest's entrance on a larger scale. This porch is elegantly groined, and exhibits in elevation a foliated arch under an ogee gable, crocketed, finialled, and springing from grotesque heads similar to those on the pinnacles of the sedilia in the interior of the chancel. The eccentric manner in which the corbelled springing for the support of the arch is derived from the buttress is worthy of notice.
11	1, 2	Details of chancel parapet, Bishopstone Church.
	3, 4, 5, 6	Details of chancel buttresses ditto.
	7	Sketch of a portion of the parapet of the south aisle, Stoke Golding Church.
	8	Sectional details of the parapet, cornice, and basement-moulding of the south aisle, Stoke Golding Church.
11	9	Remains of one of the pinnacles from the east end of Stoke Golding Church.
	10	Cross, terminating the chancel gable, ditto.
	11	Cross, terminating the gable of the south chantry, ditto.
	12	Single piscina from Stoke Golding Church.
	13	Double piscina, ditto.
12	1	Plan and elevation of a piscina in the north transept, Bishopstone Church.
	2	Details of tracery, chancel windows, Bishopstone Church.
	3	Plan of window jamb.
	4	East window of chancel, Maidstone Church.
	5	Clerestory window, ditto.
	6	Plan of jamb mouldings.
	7	Clerestory window from the nave, Maidstone Church.
	8	Plan of jamb moulding.
	9	Window in the north wall of the chancel, Stoke Golding Church. The jamb-mouldings are shown at fig. 4, plate 13.
13	1	Elevation of the chancel window of Stoke Golding Church, restored; the enriched cinquefoil of the upper circle being destroyed. The lines of the jambs of this window, instead of forming tangents to those of the arch, form angles with them on the line of the spring of the tracery, which is a peculiarity not often met with, nor is it pleasing; but the superior richness of the mouldings, and the composition of the tracery, compensate fully for any disappointment that may be felt at the first discovery of any eccentricity.
	2	Section of mouldings.
	3	Window from the north aisle, Stoke Golding Church.
	4	Jamb-mouldings.
	5	Window from the nave, Stoke Golding Church.
	6	Jamb mouldings.
	7, 8	Windows of the south aisle, Stoke Golding Church. The small medallion at the intersection of the tracery is a peculiarity and a beauty, as is also the shallow channel, or quirk, which divides the front member of the mullion, and with it traverses the tracery; the deep hollow sunk from the main face of the wall at the under side of the label, terminating on the spring line by a point, by the introduction of which a superior richness is acquired for the label, is dispensed with when the same moulding is used as a string course.
	9	Jamb mouldings.
14	1	Elevation of "Founder's Tomb," Bishopstone Church.
	2	Plan, section, and elevation of a tomb recess, at Stoke Golding Church.
15		Sedilia from Bishopstone Church.
16		Details of sedilia do.

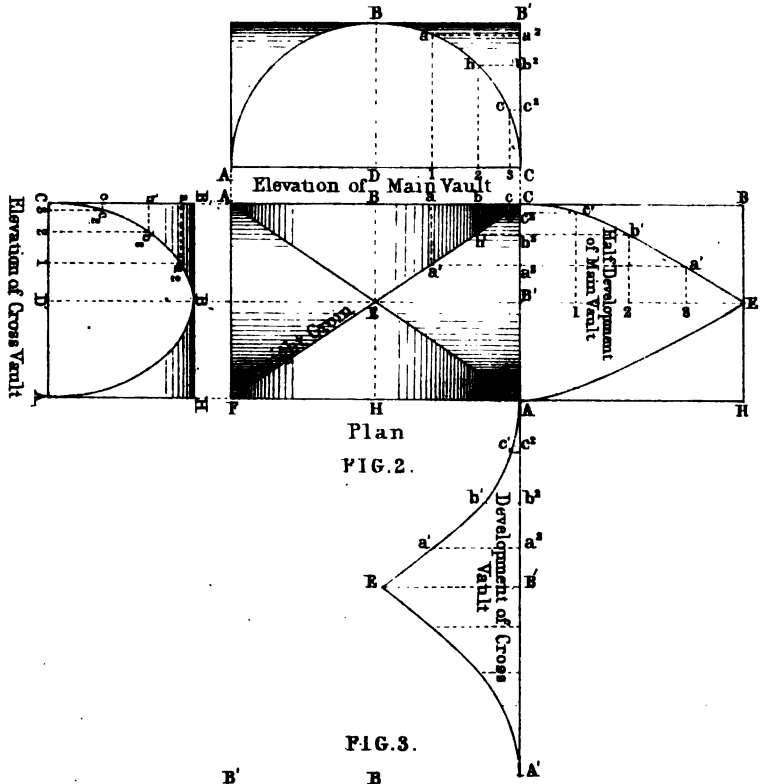
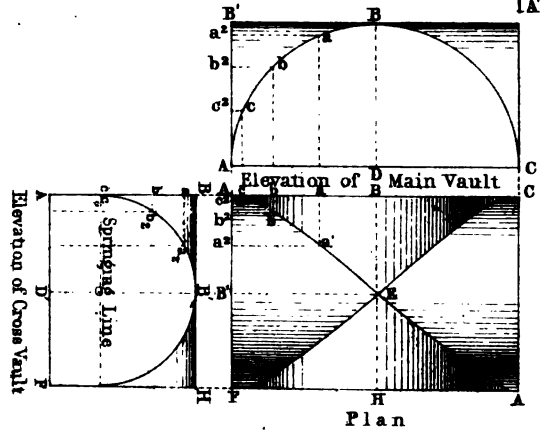


FIG. 2.

FIG. 3.



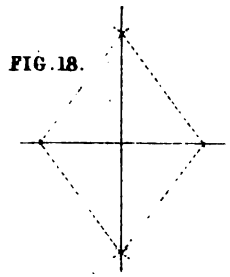
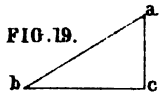


FIG. 18.



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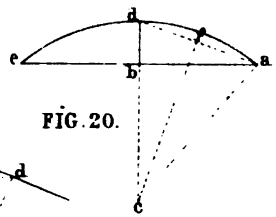


FIG. 20.

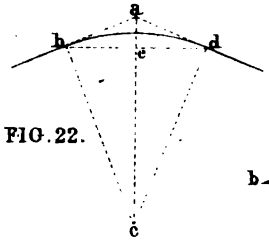


FIG. 22.

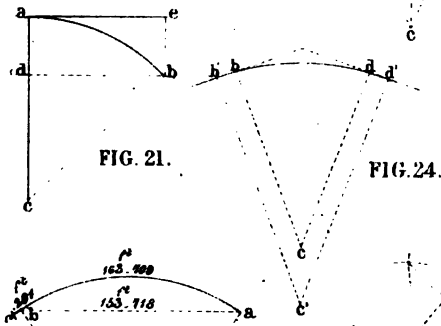
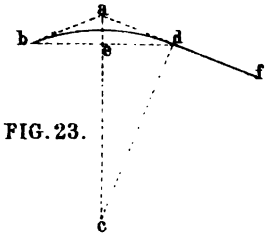


FIG. 21.

FIG. 24.



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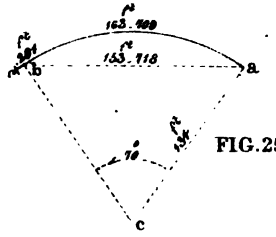

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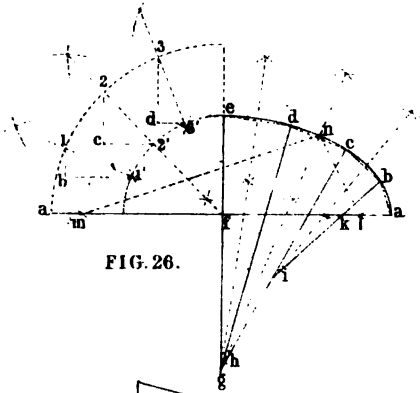


FIG. 26.

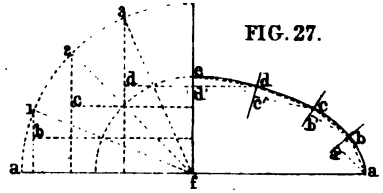


FIG. 27.

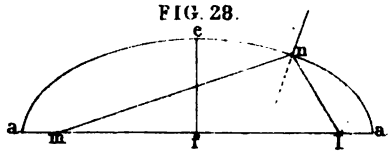


FIG. 28.

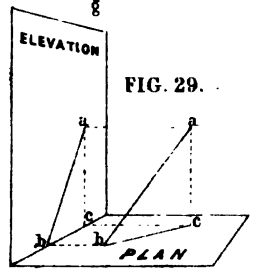


FIG. 29.

John Weale. 59 High Holborn Dec^m 1^st 1849

I. R. Jobbins. lith.

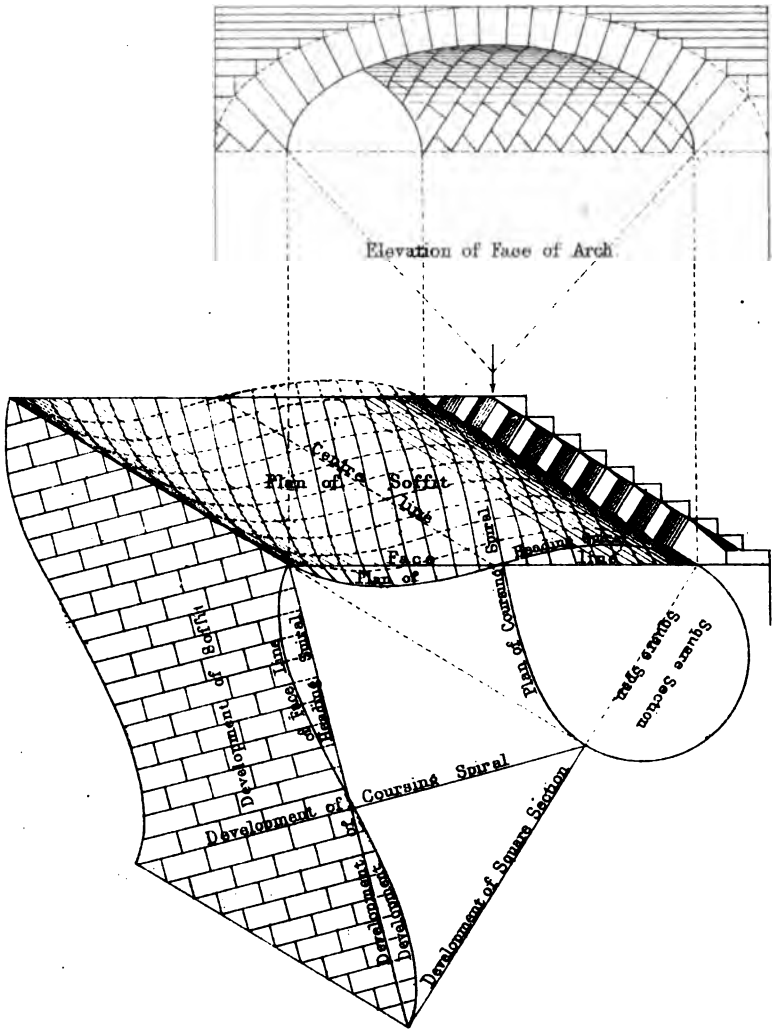


FIG. 11.

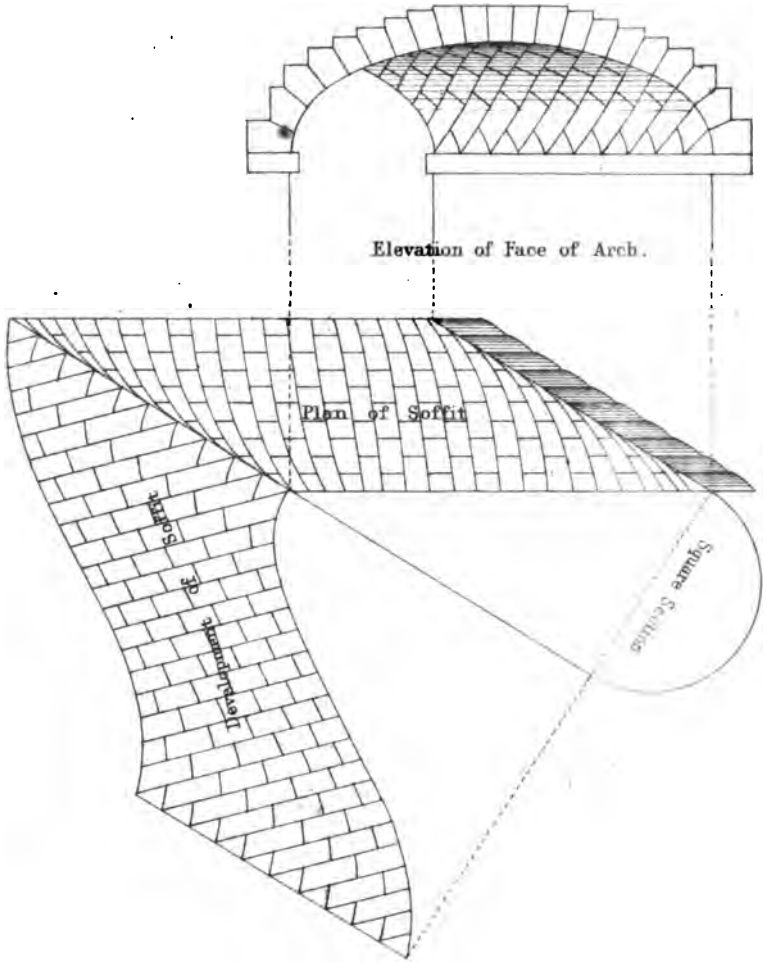
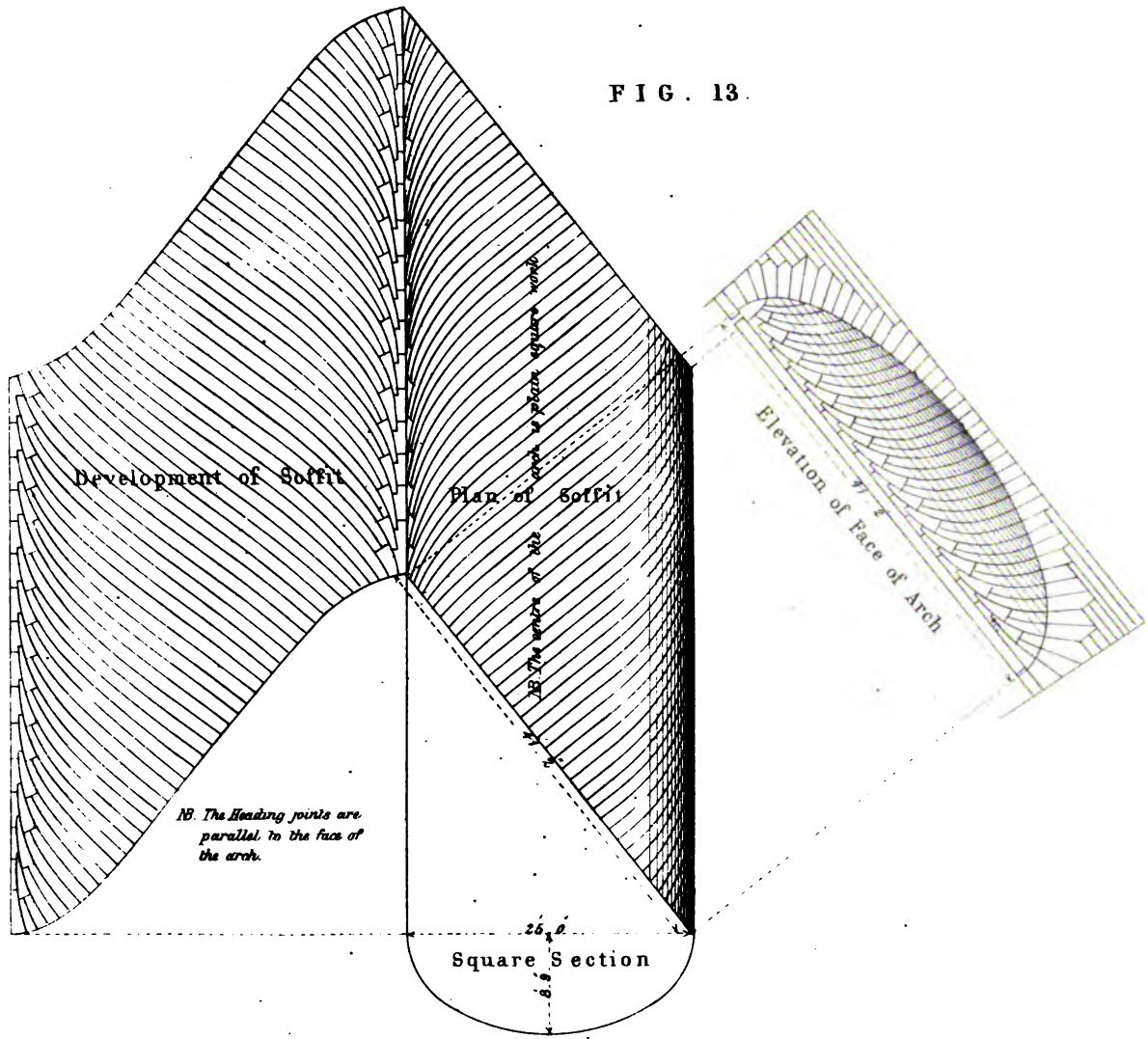


FIG. 12.

John Weale 59 High Holborn, Dec.r 1 1849.

J R Jobbins lith

FIG. 13.



John Weale 59 High Holborn Dec^m 1 1849.
J R Jobbins lith

FIG. 37.

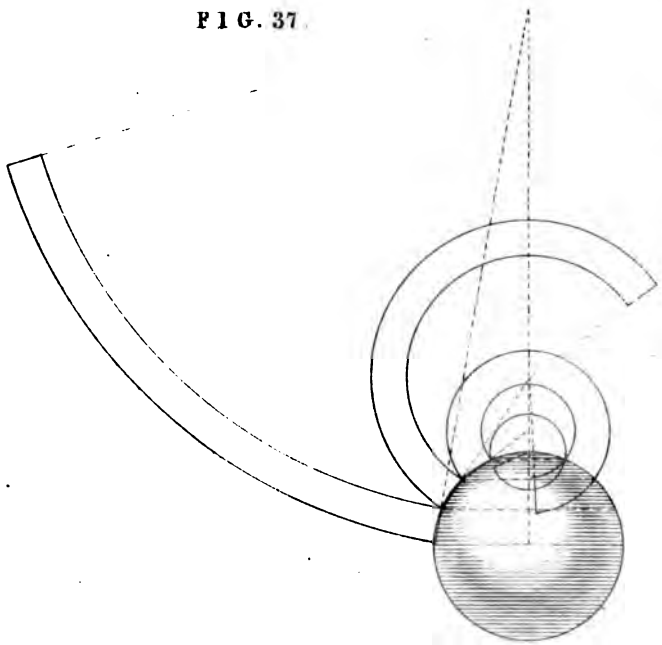
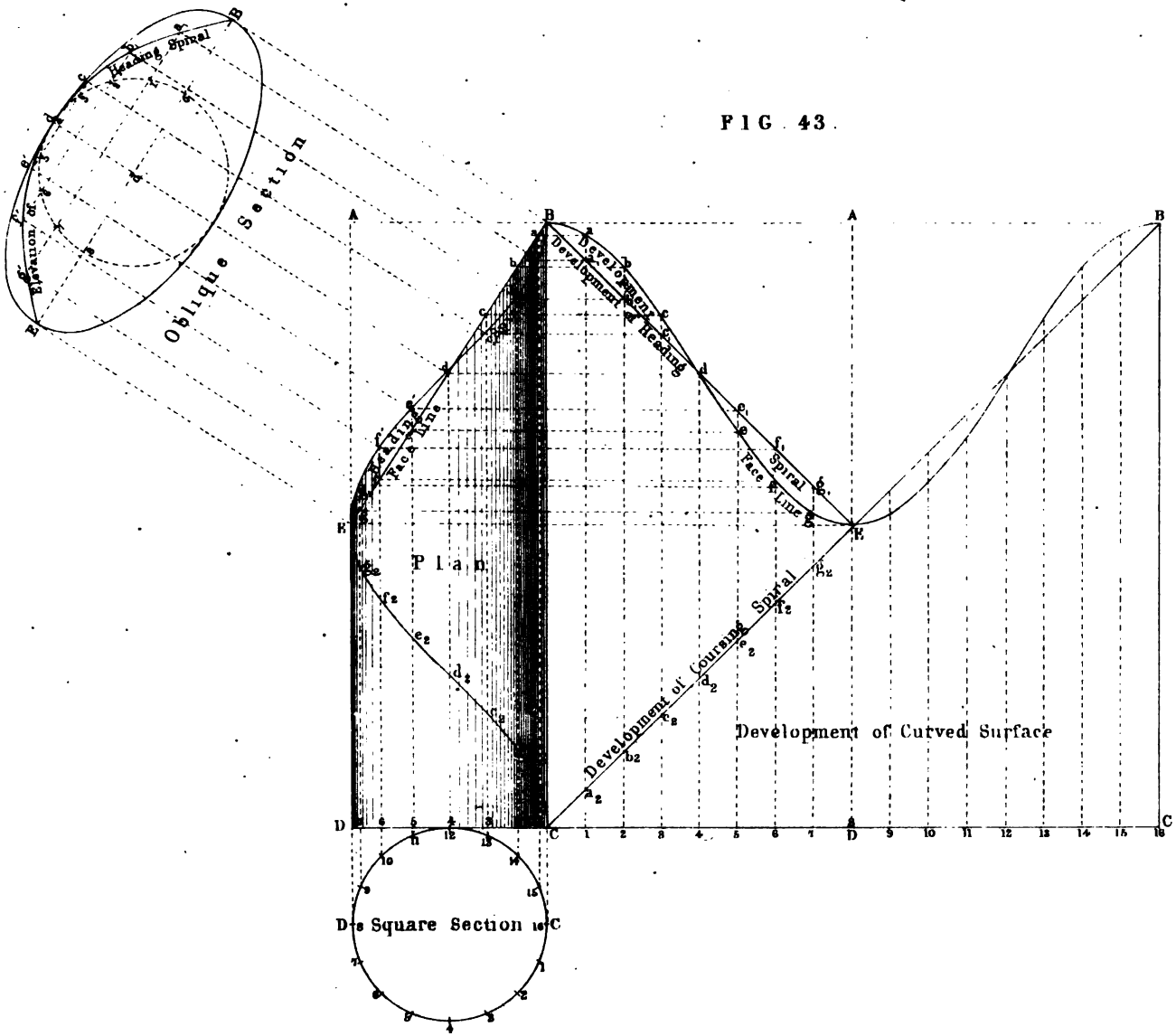


FIG. 38.

Front Elevation
Side Elevation
Development of Cylinder
Base of Right Cone
Oblique Section
Development

FIG. 43.



John Weale 59 High Holborn Dec.r 1 1849

J. R. Jobbins lith

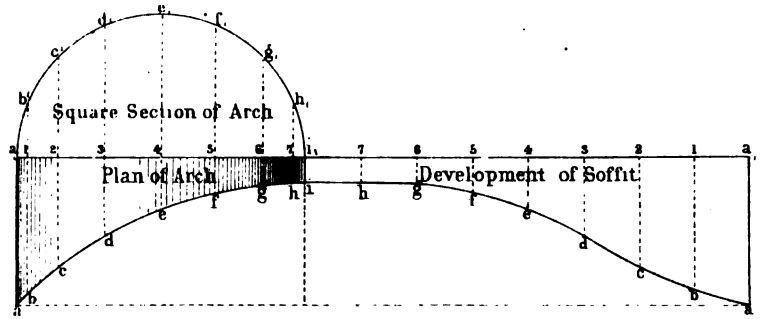


FIG. 44.

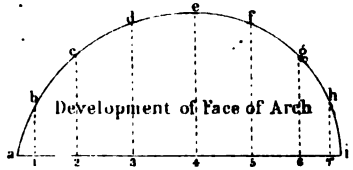


FIG. 45.

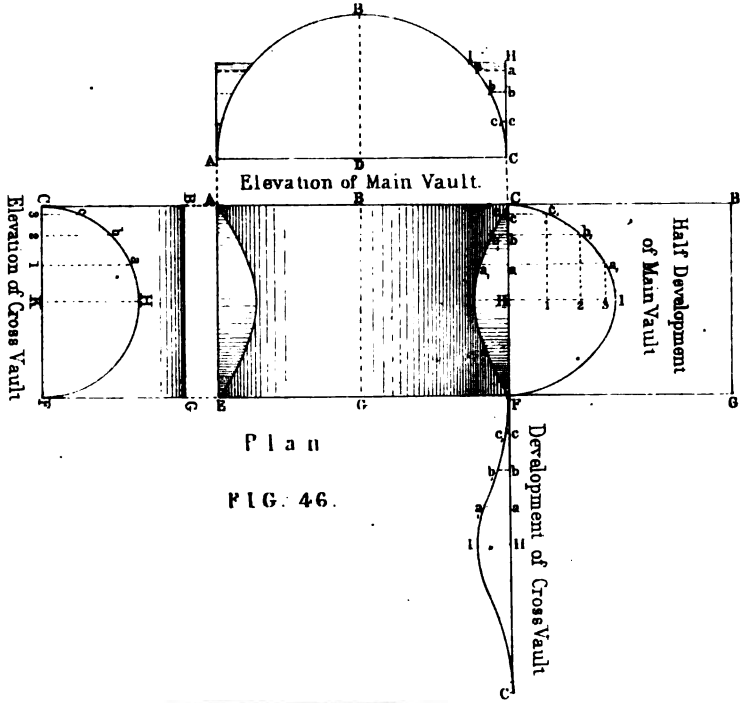


FIG. 46.

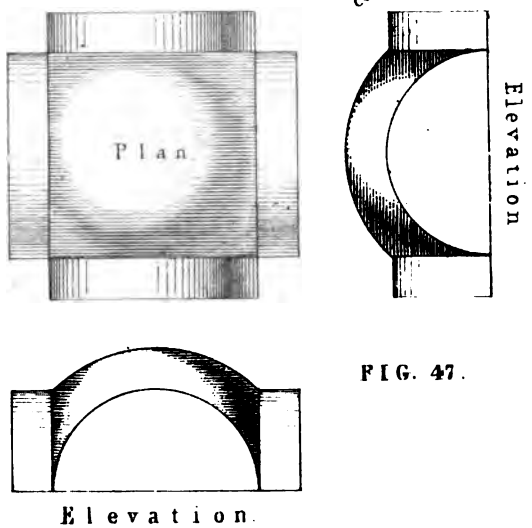
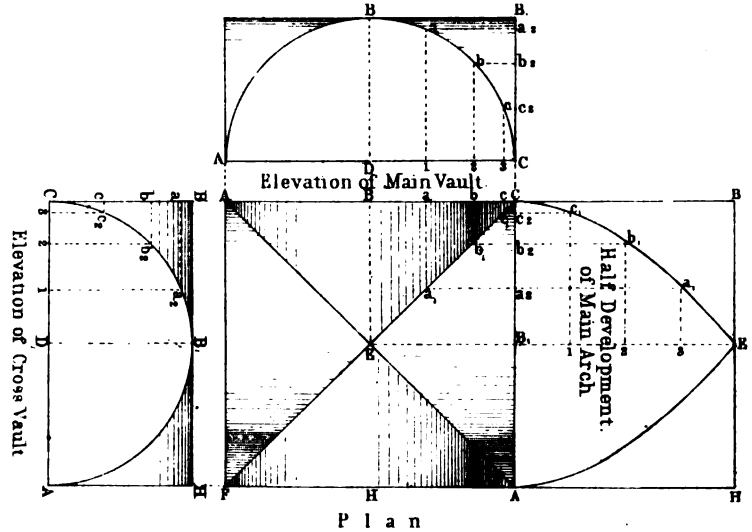


FIG. 47.



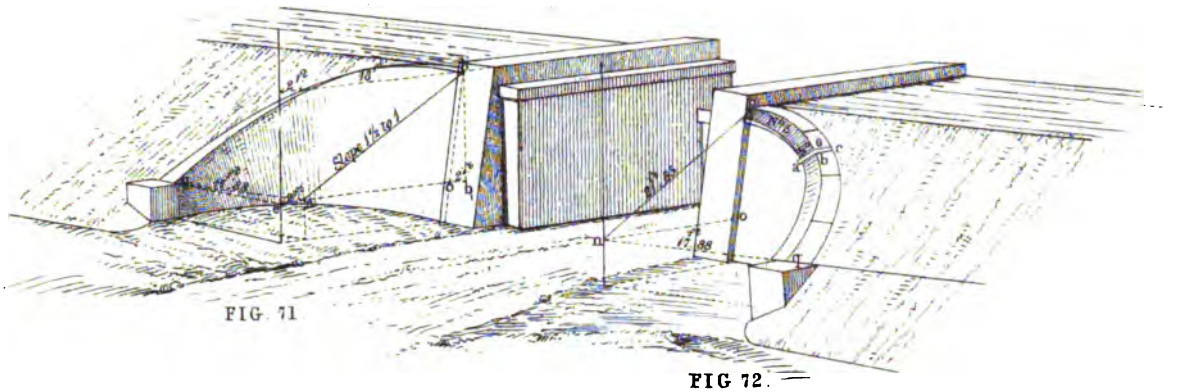


FIG. 71

FIG 72.

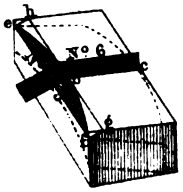


FIG. 73.

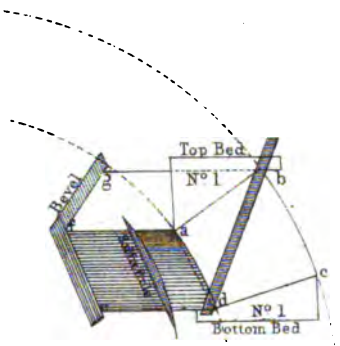


FIG. 74.

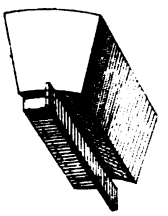


FIG. 75

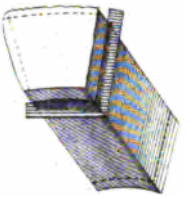
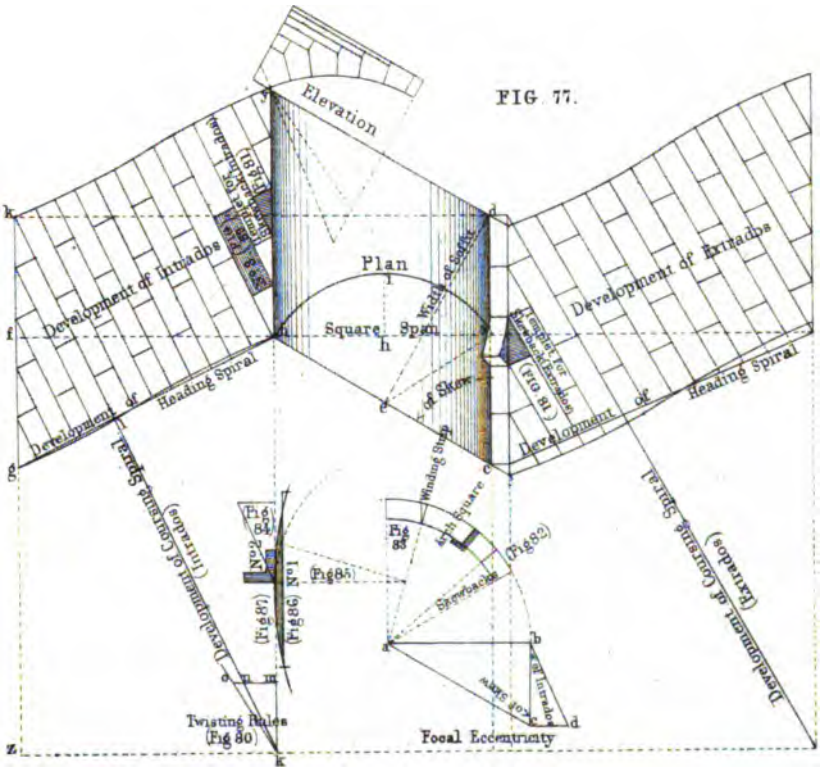


FIG. 76.

FIG. 77.



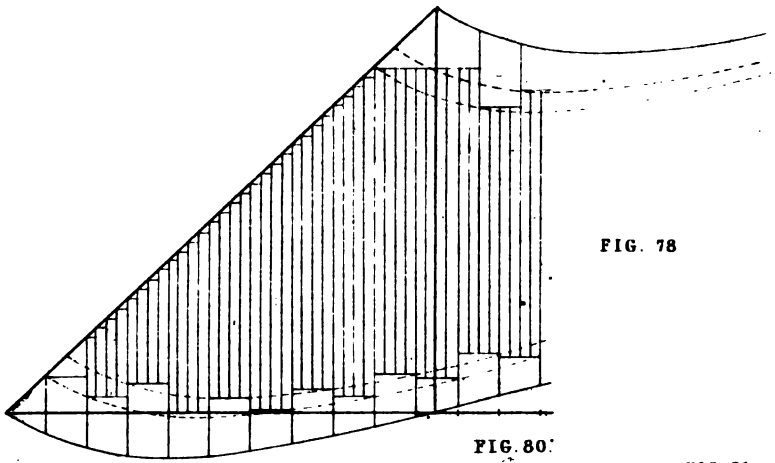


FIG. 78

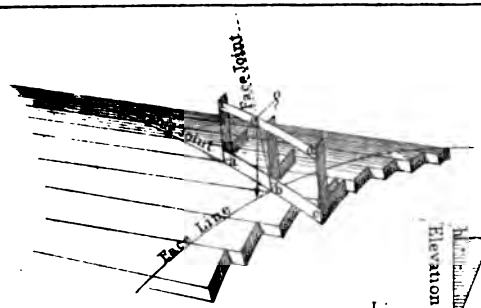


FIG. 90

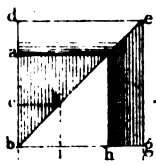
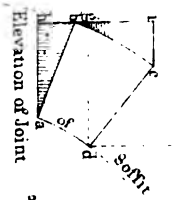
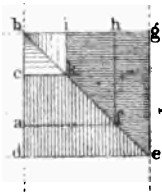


FIG. 91





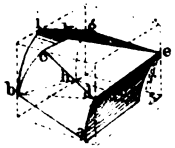
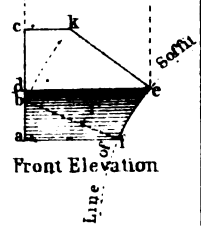


FIG. 92.



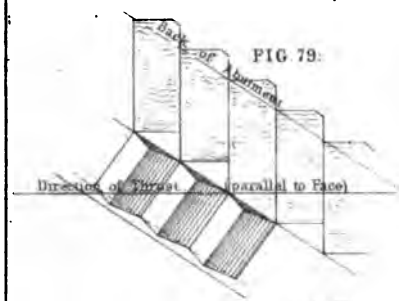


FIG. 79.

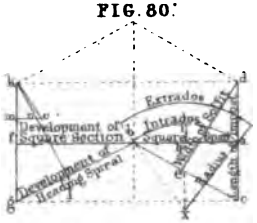


FIG. 80.

FIG. 81.

FIG. 98.

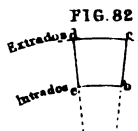


FIG. 82.

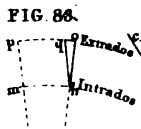


FIG. 83.

FIG. 84.

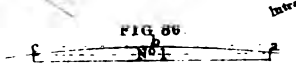


FIG. 86.

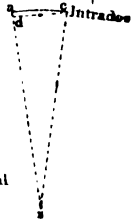


FIG. 85.

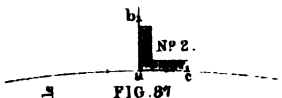


FIG. 87.

FIG. 88.

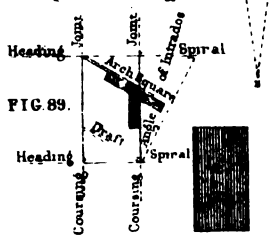


FIG. 89.

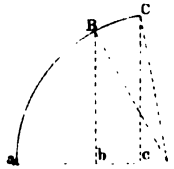


FIG. 94.

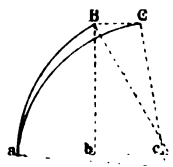


FIG. 95.

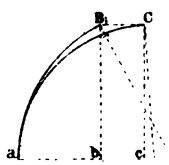


FIG. 96.

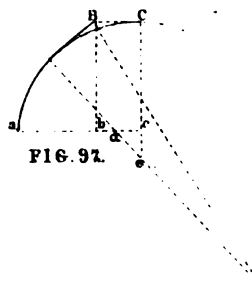
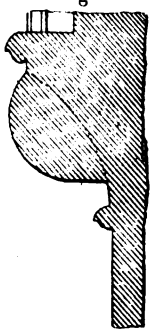


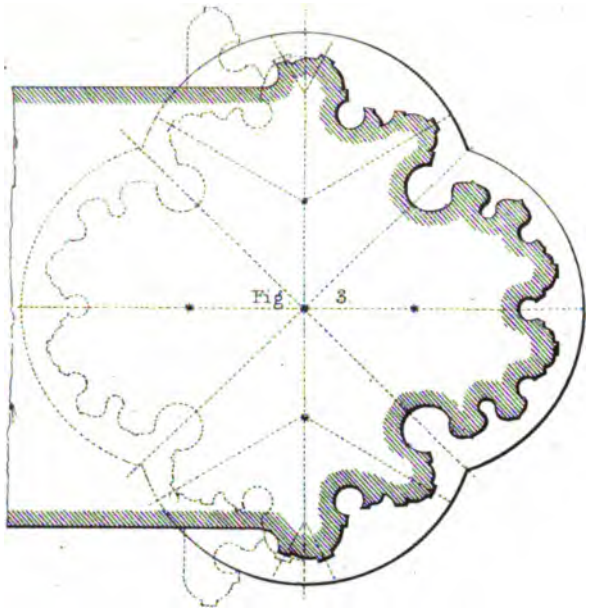
FIG. 97.

John Weale, 59 High Holborn, Dec.r 1 1849.

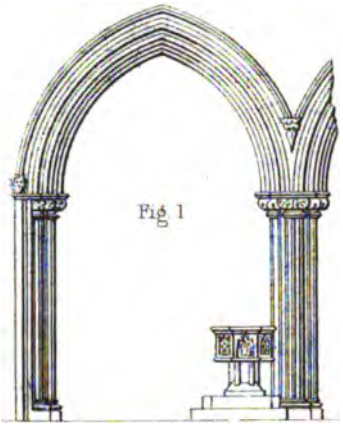
J R Jobbins lith

Fig 5.

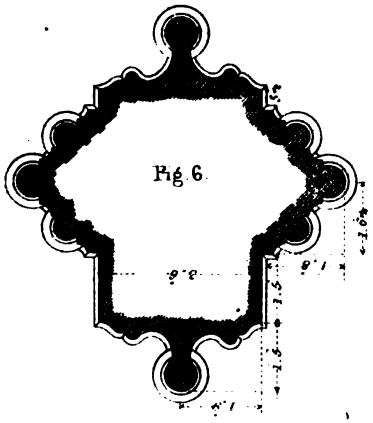




Scale 1in to a foot



Scale 1/8in to a foot



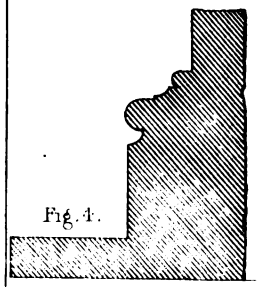


Fig 5.

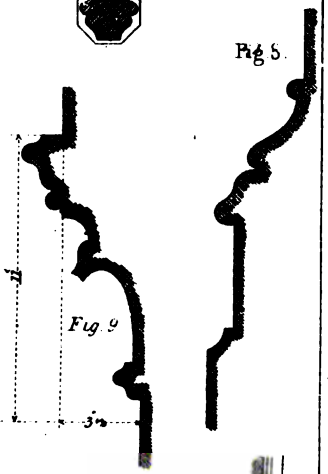
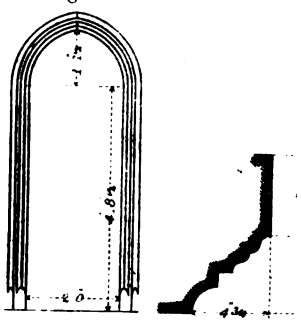


Fig 10.



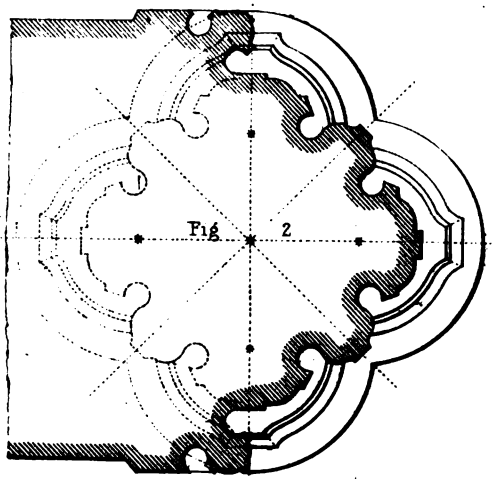
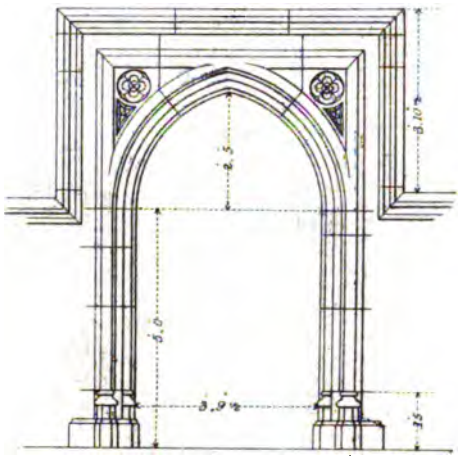
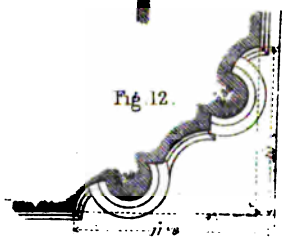


Fig 11.





John Weale 59 High Holborn Decr 1.1849.

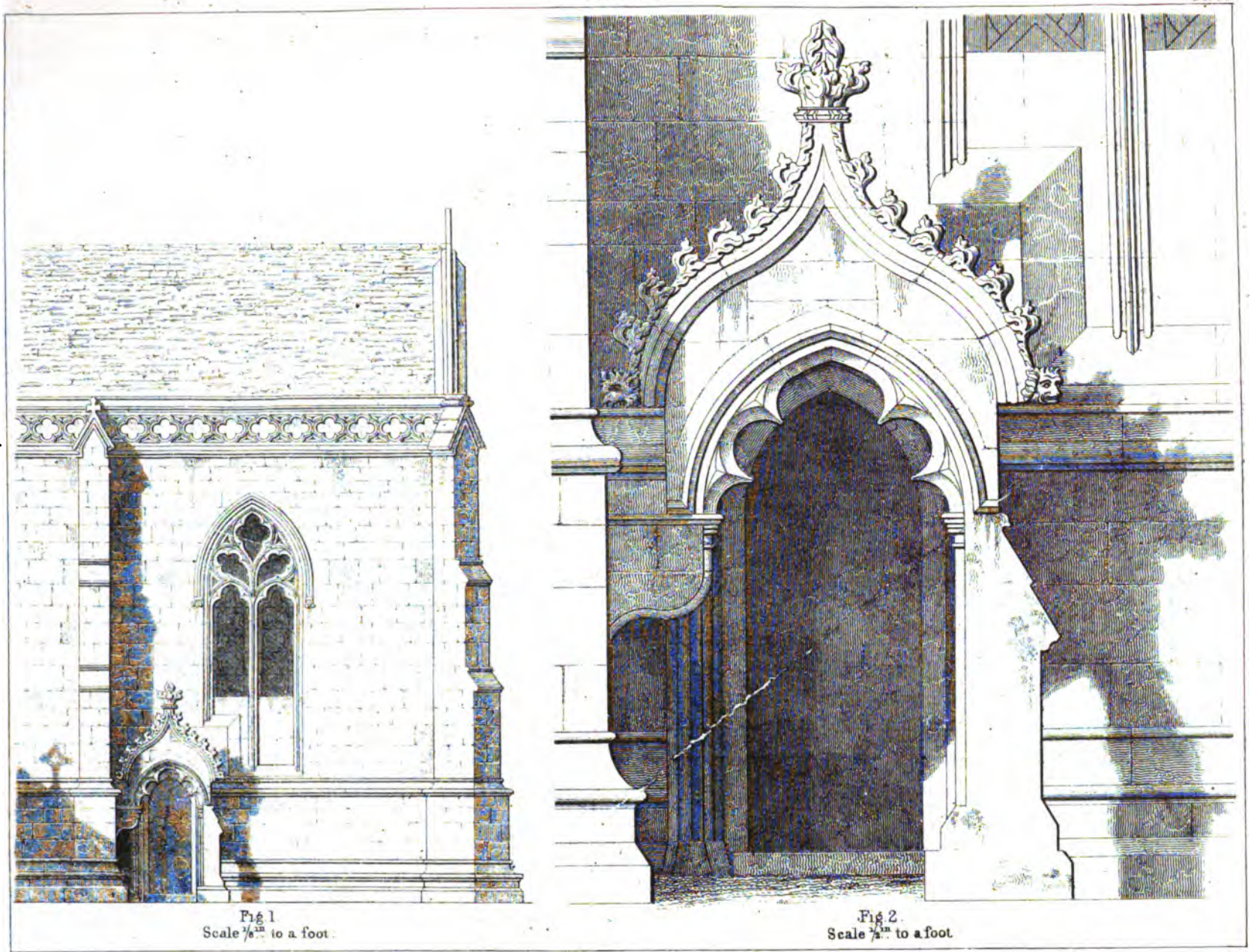


Fig 1
Scale 1/8 in to a foot

Fig 2
Scale 1/2 in to a foot

John Weale 59 High Holborn Dec^m 1 1843

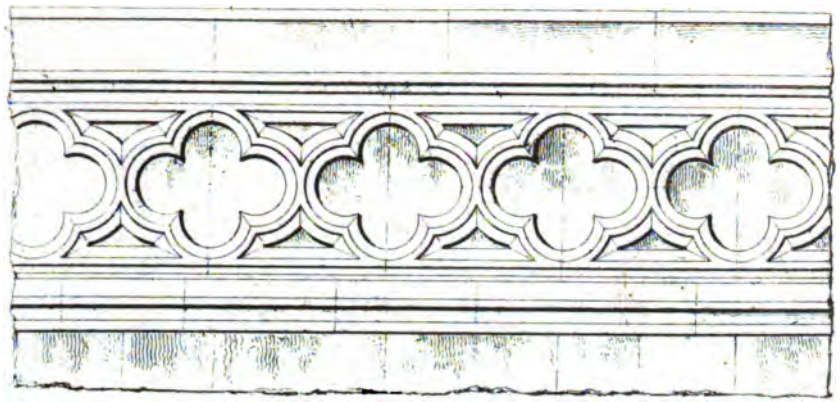


Fig. 1

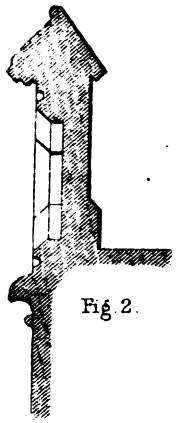


Fig. 2.

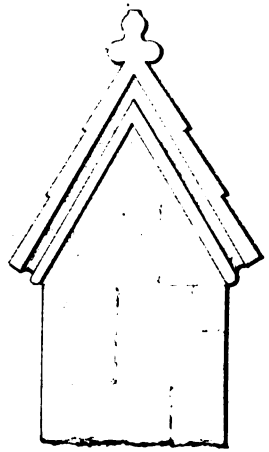


Fig. 3

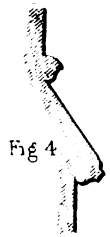


Fig 4

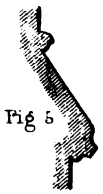


Fig 5

Fig 6

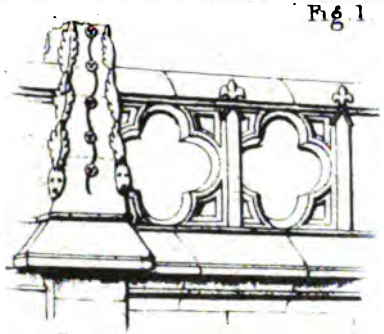


Fig. 7.

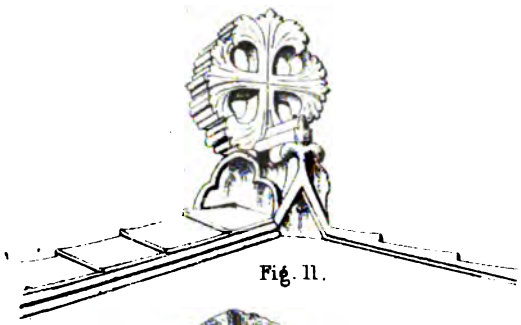


Fig. 11.

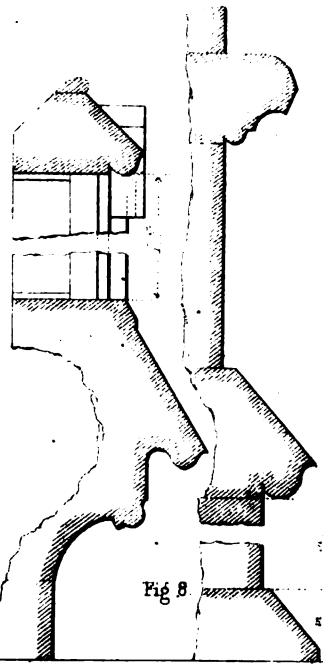


Fig 8.

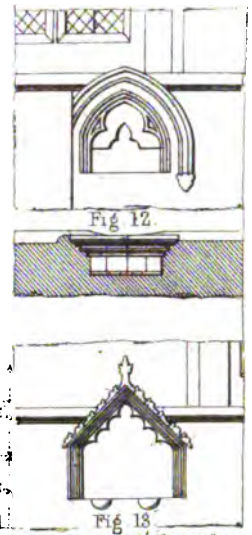


Fig 12.

Fig 13

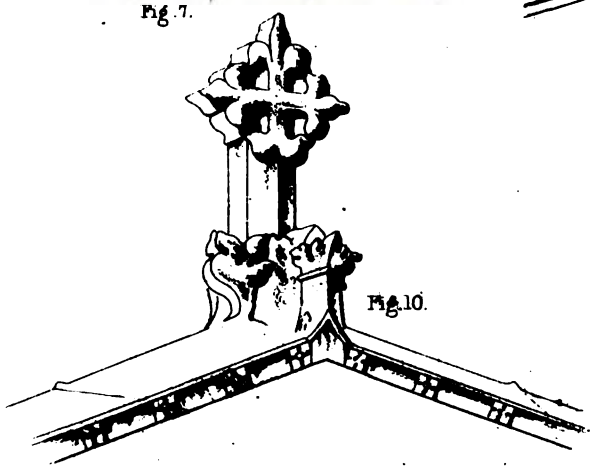


Fig. 10.

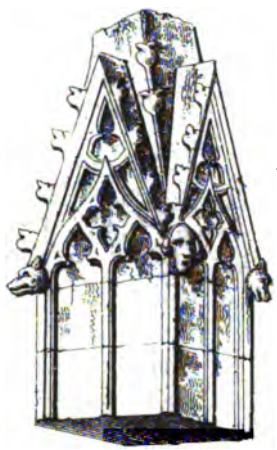


Fig 9.

Scale to 1, 2, 3, 4, 5 and 6 ½ in. to a foot

Fig 8. 1 in. to a foot

Figs 12 and 13 ¼ in. to a foot.

John Weale 59 High Holborn Dec.r 1. 1849

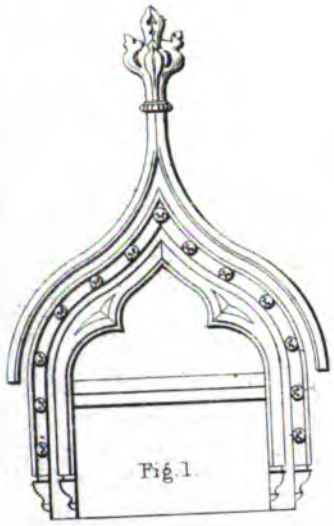
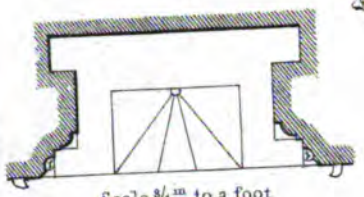


Fig. 1.



Scale ¾ in. to a foot

Fig. 2
Scale ½ in. to a foot

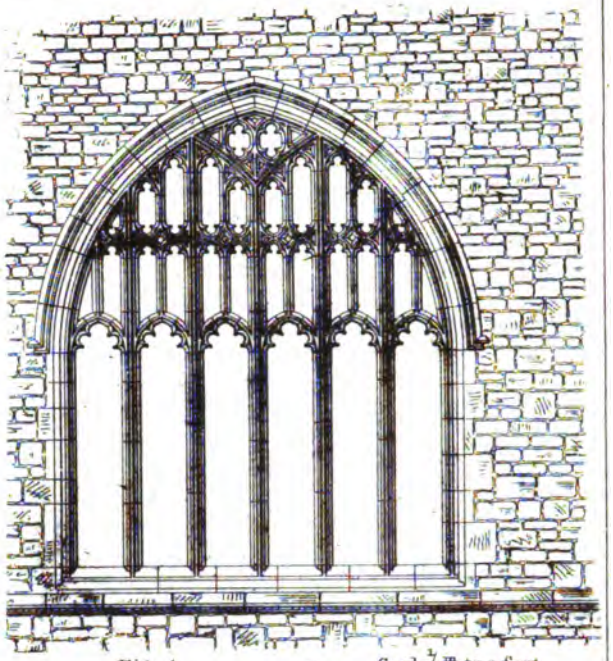


Fig. 4. Scale ⅛ in. to a foot

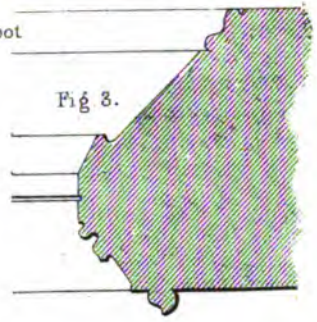


Fig. 3.

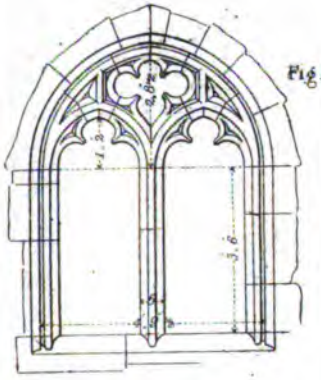


Fig. 5.

Fig. 7

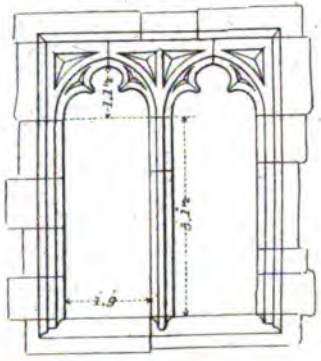
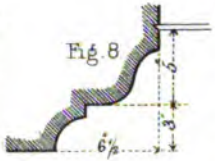


Fig. 6.

Fig. 8



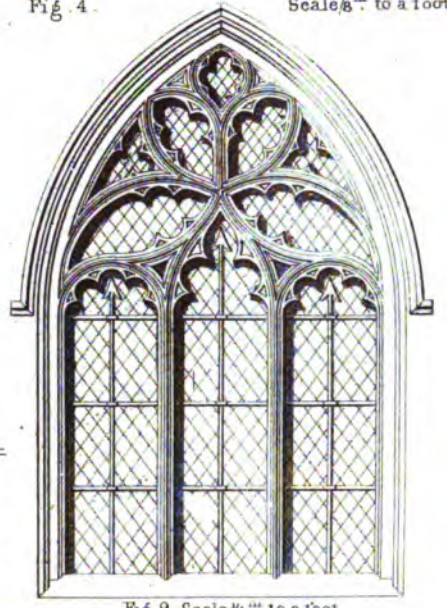


Fig. 9. Scale ¼ in. to a foot

John Weale 59 High Holborn. Dec^r 1. 1849

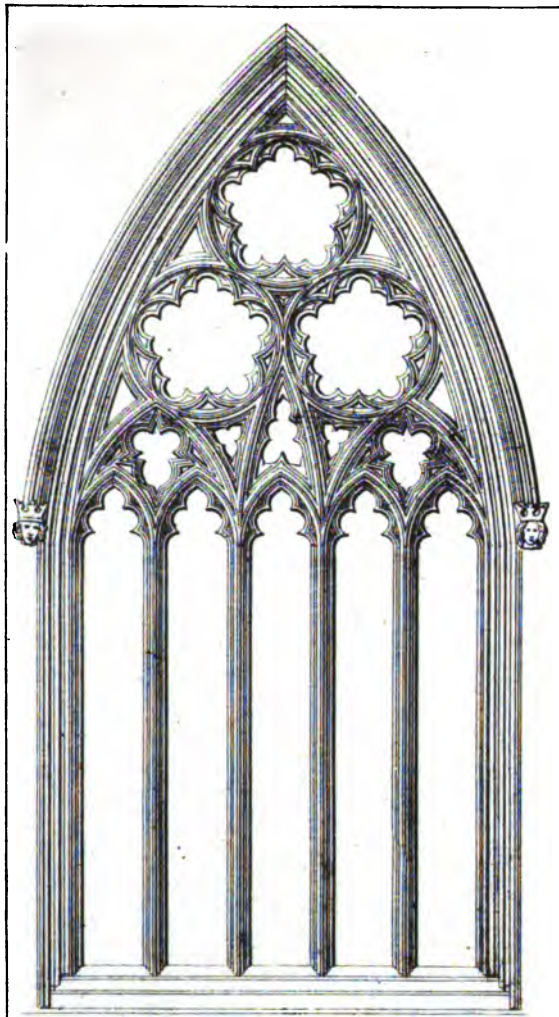


Fig. 1.

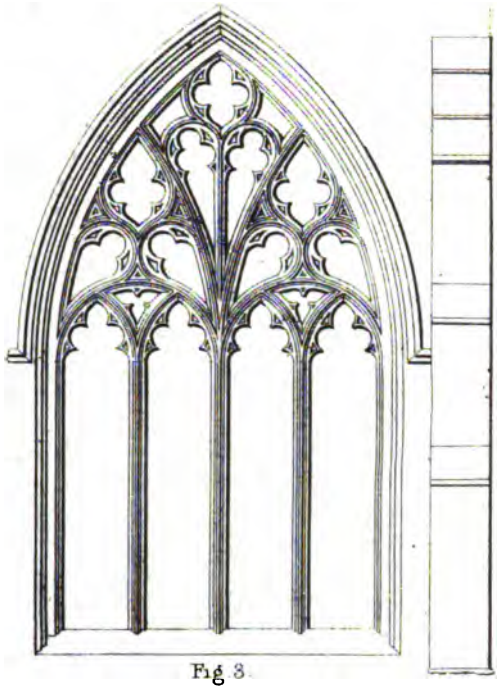


Fig. 3.

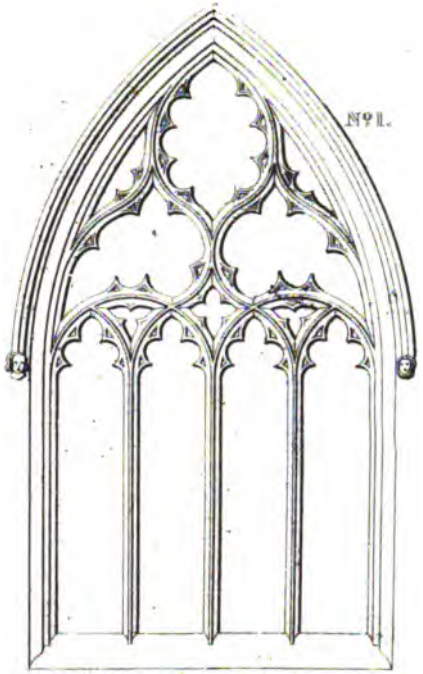
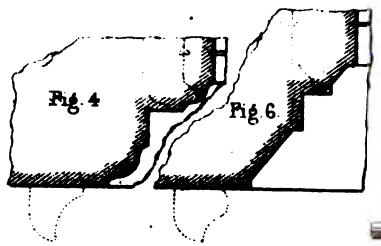


Fig. 5.



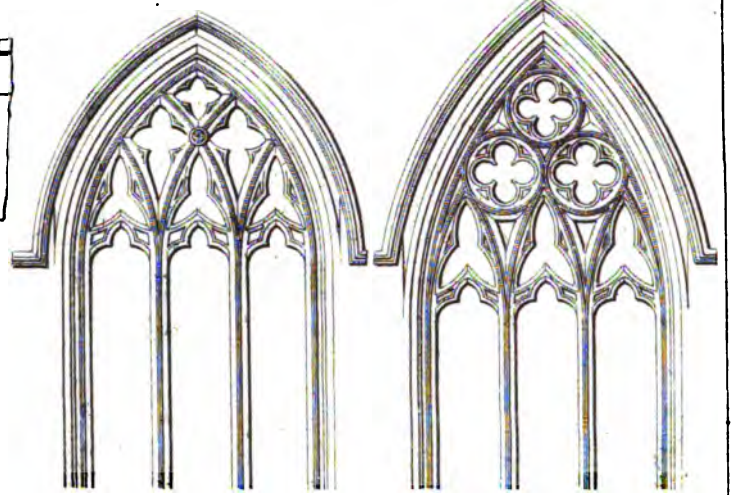
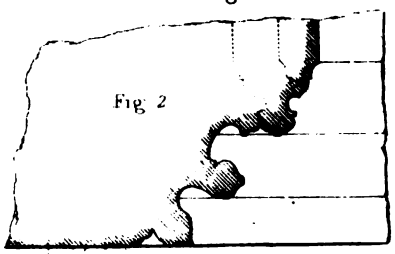
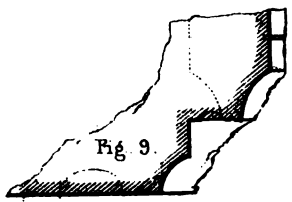


Fig. 7. Fig. 8.





Scale ¾ in to a foot

Details 1 in to a foot

John Weale 59 High Holborn Dec^m 1. 1849

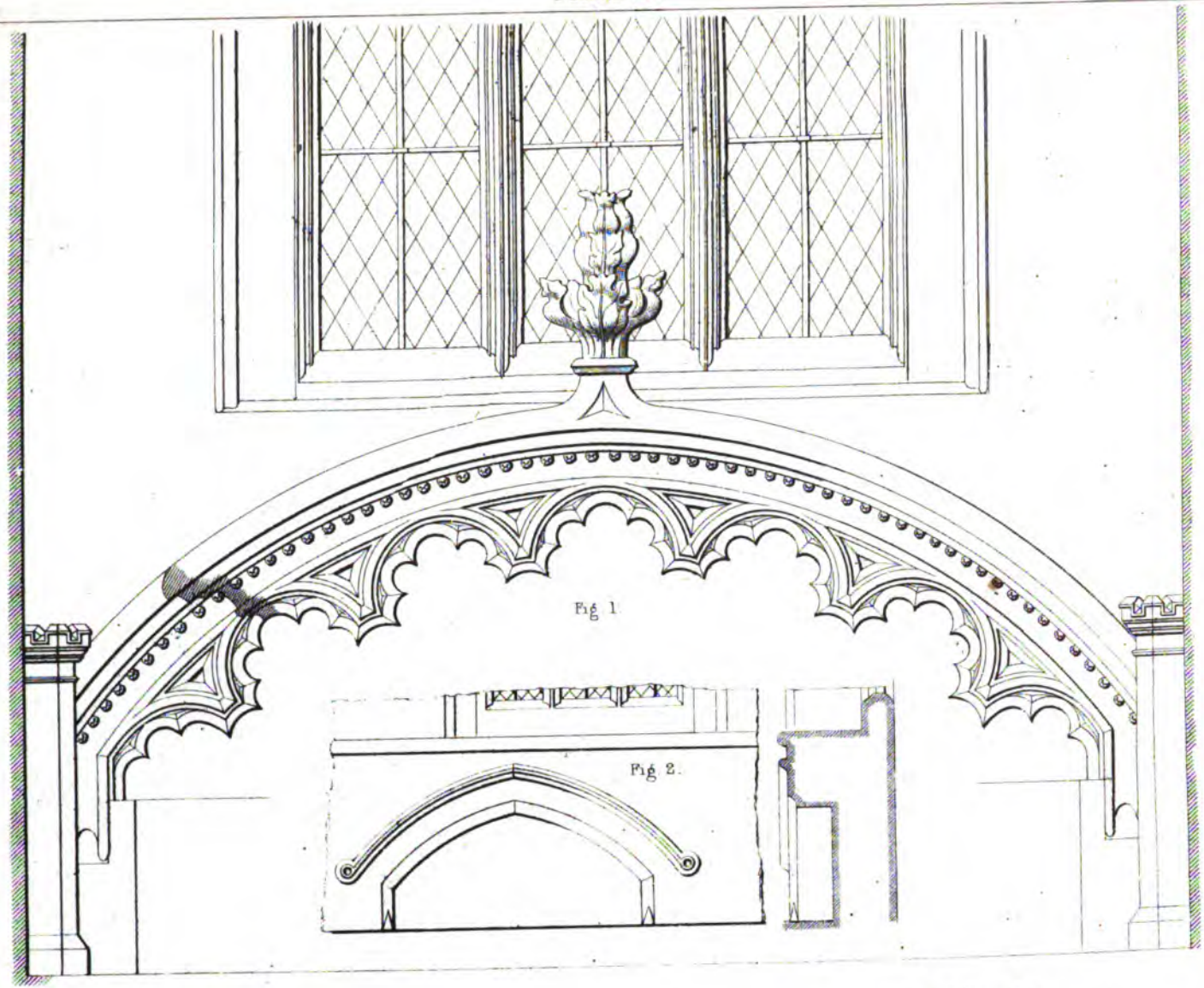
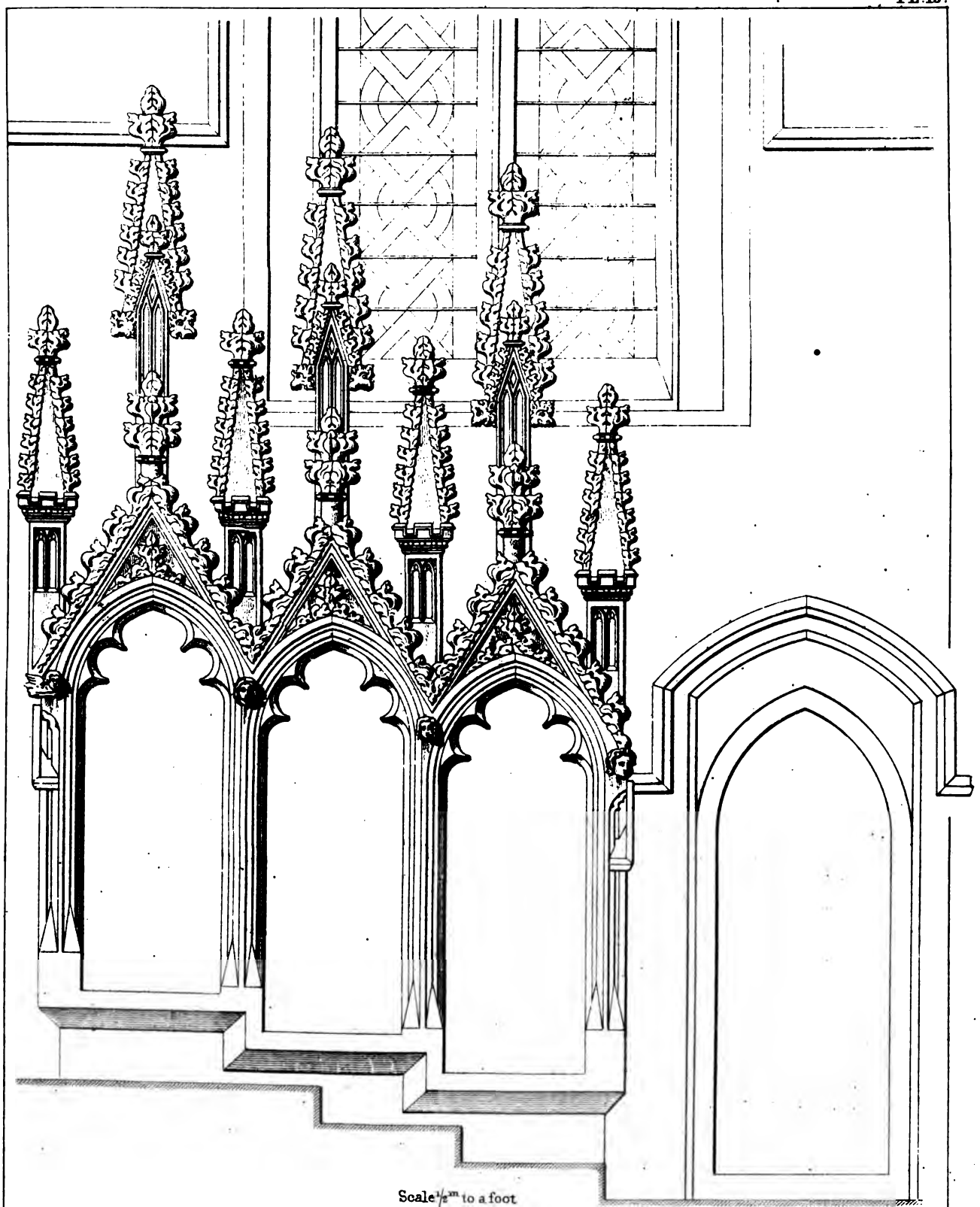


Fig 1½in to a foot

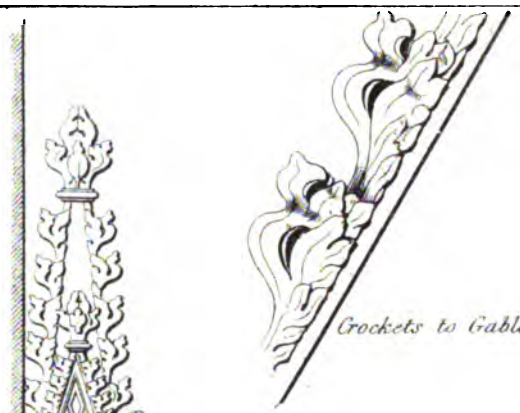
Fig 2 ⅛in to a foot

John Weale 59 High Holborn Dec.r 1 1849

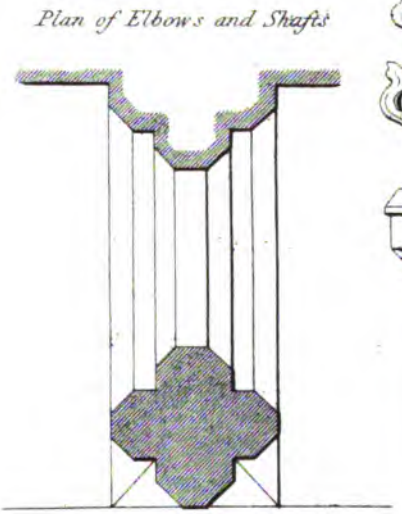


Scale 1/2in to a foot

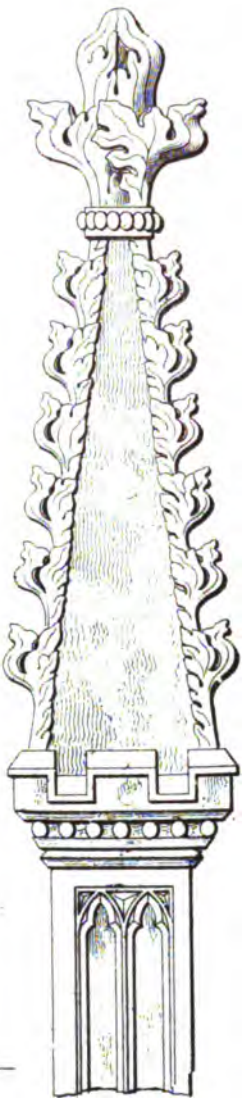
John Weale 59 High Holborn Decr 1 1849.



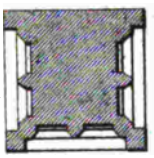
Crockets to Gables



Plan of Elbows and Shafts

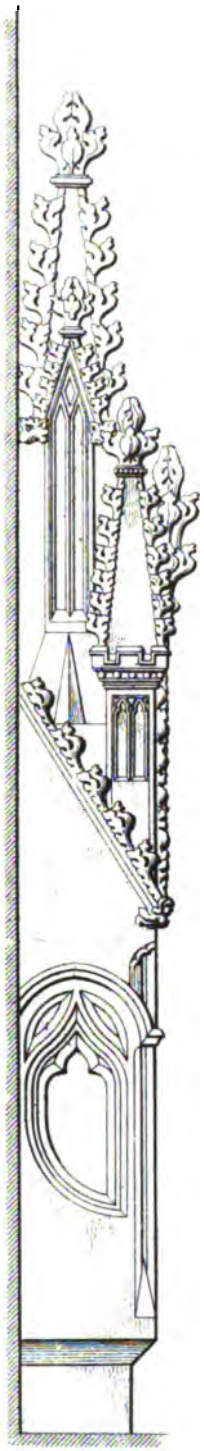


Elevation of Lower Pinnacle



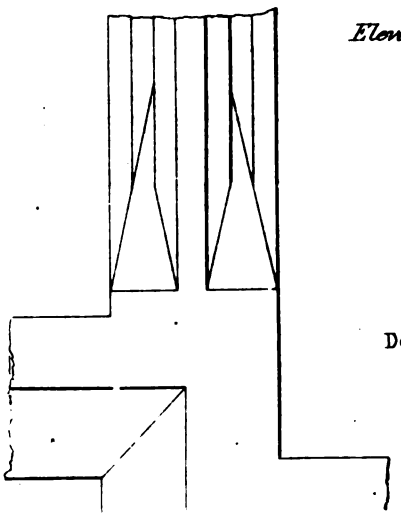
Plan

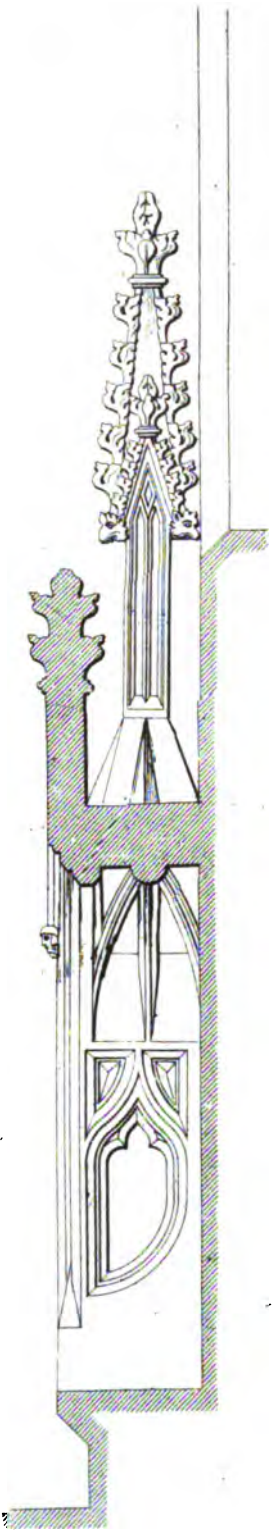
Details ⅛ the actual size



End Elevation

Scale ½ Inch to a Foot





Section

Scale ⅛ Inch to a Foot

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